Vol. XXXII JANUARY-FEBRUARY-MARCH, 1949 No. 3

THE PHILIPPINE AGRICULTURIST

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A

CONTENTS

Published by
THE COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

The Philippine Agriculturist

(University of the Philippines Publications Series A)

THE PHILIPPINE AGRICULTURIST is published quarterly, beginning with Volume 31, by the College of Agriculture, University of the Philippines, in Los Baños, Laguna. The subscription price is ₱6.00 a year in the Philippines and $4.00 (U.S. currency) elsewhere; the price of single copies, ₱2.00 in the Philippines and $1.00 (U. S. currency) elsewhere.

Business correspondence should be addressed to the Business Manager, THE PHILIPPINE AGRICULTURIST, College, Laguna, Philippines. All remittances should be made payable to THE PHILIPPINE AGRICULTURIST.

Communications for the editor should be addressed to the Editor, THE PHILIPPINE AGRICULTURIST, College, Laguna, Philippines.

Publications sent in exchange for THE PHILIPPINE AGRICULTURIST should be addressed: Library, College of Agriculture, College, Laguna, Philippines.

Entered at the Post Office at College, Laguna, Philippines, as second-class mail matter.

A COMPARATIVE STUDY OF FOUR VARIETIES OF RAMIE [1]

MARIO C. BELISARIO

WITH THREE TEXT FIGURES

Several ramie varieties which are believed to be the result of hybridization, selection, and acclimatization of varieties introduced from abroad by Japanese firms in 1911, are reported to be grown in the Philippines. Among these are Saikeiseisin, Guiran Taipan No. 1, Formosa, and Kogai. [2]

Notwithstanding the interest currently being manifested in ramie, there exists a grave inadequacy in the amount of accurate working knowledge regarding ramie varieties. This work was therefore conducted from May, 1947, to February, 1948, in the Experiment Station and in the Fiber Division laboratory of the Department of Agronomy, College of Agriculture, Los Baños, Laguna, with a view of studying the botanical characters of the above-mentioned varieties as well as their yield and other agronomical features.

MATERIALS AND METHODS

Varieties

Entire roots of the varieties Saikeiseisin, Guiran Taipan No. 1, Formosa, and Kogai were dug up in Davao [3] and shipped by plane to Manila and immediately transported to the College of Agriculture.

Equipment

Aside from the ordinary implements used in preparing and cultivating the land, in harvesting the stalks, and in gathering the necessary data, a ramie decorticating machine and a 2-5 h.p. gas engine [4] were also used in this experiment.

Land

Area and condition. The land used is fairly high and level and has an area of approximately 1,845 sq. m. It is of clay loam

---

[1] Experiment Station Contribution No. 1508. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1948. Prepared in the Department of Agronomy under the direction of Associate Professor Pedro A. David.

[2] Authors vary with regard to the varieties grown commercially in the Philippines. Cruz (1946) and Jamias (1946) reported the varieties Saikeiseisin, Chuma, and Guiran Taipan No. 1 as of commercial importance. Capili (1947) reported that the varieties planted in Davao are, in the order of their importance, as follows: Saikeiseisin, Guiran Taipan No. 2, Guiran Taipan No 1, Formosa, and Chuma. David (1939) reported that Saikeisesin was the variety raised commercially by the Ohta Development Company in Davao.

[3] The author wishes to acknowledge his indebtedness to Mr. Mariano Pamintuan and to Dr. Juan Belisario, both of Davao City, for their assistance and co-operation in obtaining rootstocks of the ramie varieties.

[4] The author expresses his gratitude to the Mayon Engineering and Machine Shop, Manila, for the use of its decorticating equipment in this experiment.

leaves exceptionally large and numerous (fig. 1). Flower and seed clusters were abundant. In all the plots, growth was not uniform owing to the dissimilarities in the germination of the rootstocks.

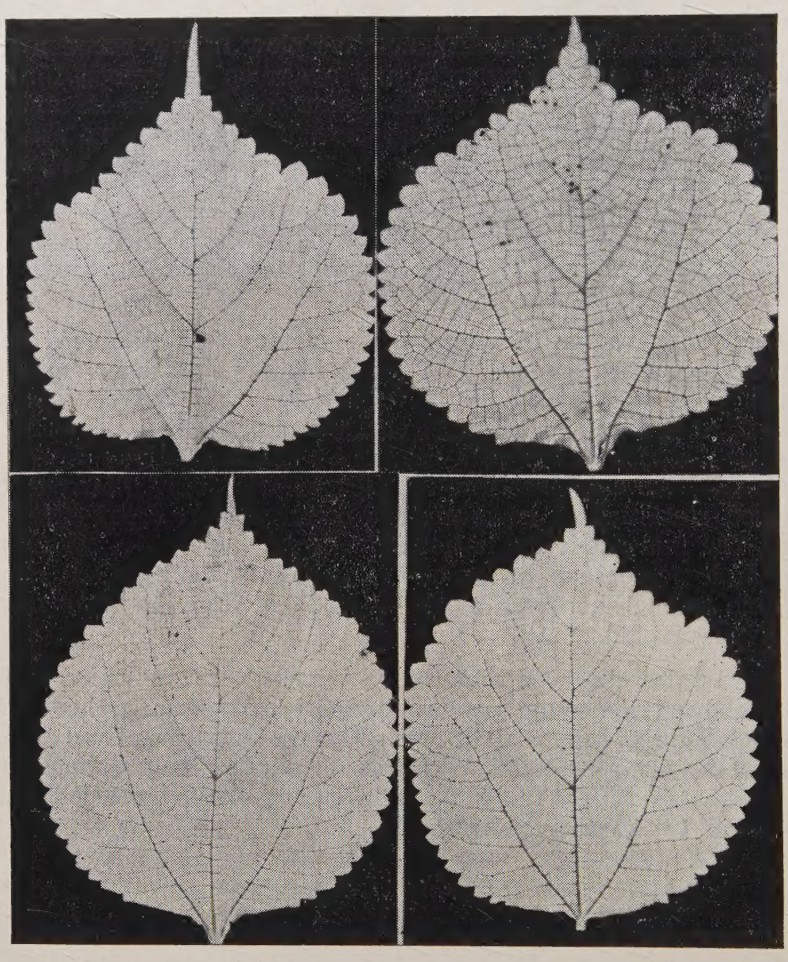


Fig. 1—Leaf prints of the nether surface of the foliage of each of the four varieties of ramie, *Boehmeria nivea* (L.) Gaudich, studied showing leaf apex. Upper panel, left, Saikeiseisin; right, Guiran Taipan No. 1. Lower panel, left, Formosa; right, Kogai. About ×½.

The plants in the second harvest appeared poor in condition. They were very short in comparison with previous crop, and lacked the vigor and luxuriance of the latter. The leaves were small and somewhat chlorotic, and tended to fall off rather prematurely. The plants in plots Nos. 5 to 10 were specially stunted and heavily infected with leaf spots. Infection with leaf spots and in-

festation of insect larvae were heavier this time than in the previous crop. Growth in the different plots, however, appeared more uniform owing to the cutting down of the sprouts to even heights immediately after the first cutting. A number of typhoons with rains passed over the locality and although not much external damage was visible, the plots were flooded. The most destructive typhoon occurred on December 26, 1947, and its effects were highly damaging. Many of the plants were blown down and practically all that remained standing either had been partially defoliated or the tops blown off; hence, many of the plants in the different plots were destroyed. However, flower and seed clusters were just as abundant as in the first cutting (fig. 2). The plants lacking veg-

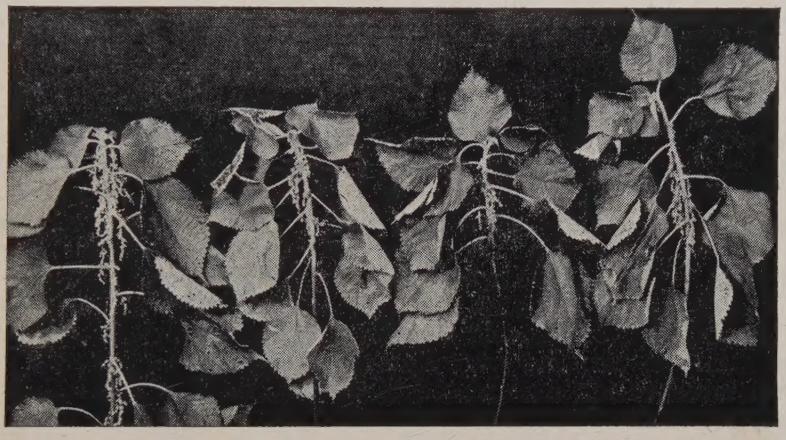


Fig. 2—Flower clusters in axillary panicles of (left to right) Saikeiseisin, Guiran Taipan No. 1, Formosa, and Kogai.

etative luxuriance, weeds grew faster, and their control was more difficult than in the first harvest. To all outward appearances, the soil seemed to have been depleted after the first cutting as evidenced by the poor stand of the plants and the greater incidence of Cercospora leaf spot, which occurs only on plants growing under extremely unfavorable conditions of soil or climate. This, plus the constant flooding of the area and the destructive effects brought by the Christmas typhoon "Jean", may be said to be the main reasons for the poor condition of the plants during the second cutting.

Susceptibility to pest and diseases

A month after planting, caterpillars were observed feeding on the leaves of the ramie plants. The caterpillars were those of the moth *Plusia chalcytes* Esper. (Noctuidae, Lepidoptera). All the varieties were equally affected. Damage was however minimized

by picking off the larvae by hand and destroying them. This pest was present during the first and second cuttings with practically the same degree of infestation.

The larvae of the moth *Sylepta sabinusalis* Walker (Pyralidae, Lepidoptera) were also observed infesting all the four varieties to a similar degree in both the first and second cuttings. This pest was controlled by picking off the caterpillars by hand. The damage caused by this pest was greater than that caused by *Plusia chalcytes*. The larvae of *Sylepta sabinusalis* had the characteristic habit of rolling the leaves of the plants.

No larvae of *Cocytodes coerulea* Guen., which was reported by David (1939), Cruz,[5] Jamias,[6] and Luistro,[7] to attack the ramie plants, were found on the plants.

Leaf spot caused by *Cercospora* sp. probably indentical with *C. boehmeriana* Wor. reported in 1946 by Cruz[8] and Jamias[9] as common among plants in poor soil or under unfavorable climatic conditions, were also found on the leaves of the plants. The spots were rusty brown, roughly rectangular in shape, and tended to coalesce into large patches. They were very prominent on the leaves that were shriveled and somewhat chlorotic. This disease was noted only on plants growing in very poor soil or under adverse climatic conditions. The disease was present during the first cutting but was more prevalent during the second cutting when the weather was rather unfavorable and the soil probably depleted by previous crops. All the varieties were equally affected by the disease. The control measure taken consisted of cutting the infected leaves and destroying them.

Flowering period

In the number of days required by the different varieties to attain full bloom for the first cutting, it was observed that Saikeiseisin required the shortest period to flower fully with an average of only 47.2 days. Guiran Taipan No. 1 and Formosa came next with 60.1 and 59.1 days, respectively, and Kogai flowered last with 72.4 days. Analyzed statistically (table 2a), a highly significant difference in flowering periods was obtained. Saikeiseisin flowered earlier than any of the other varieties. No difference in flowering periods was observed between Guiran Taipan No. 1 and Formosa, but both flowered earlier than Kogai. As in the first cutting, the flowering periods of the several varieties during the second cutting showed that Saikeiseisin flowered earliest, in 47.2 days. Guiran

---

[5] CRUZ, E. E. 1946. Ramie culture in the Philippines. Dept. Agric. Comm. News Bull. 1 (3): 24-31.

[6] JAMIAS, J. 1946. Ramie fiber production in the Philippines. Farming and Cooperative 1 (6-7): 2, 3, 29.

[7] LUISTRO, F. D. 1946. Ramie growing at the Mindanao Experiment Station. Dept. Agric. Comm. News Bull. 1 (3): 64-68.

Taipan No. 1, Formosa, and Kogai followed, in 61.5, 59.1, and 69.9 days, respectively. Statistically, a highly significant difference was observed (table 2a). Again as in the first harvest, Saikeiseisin flowered earlier than any of the other varieties. No difference in flowering periods was evident between Guiran Taipan No. 1 and Formosa, but both bloomed earlier than Kogai.

These results show that as far as blooming period is concerned, Saikeiseisin flowers earliest, followed by Guiran Taipan No. 1 and Formosa, while Kogai comes last.

Maturity period

Maturity in this work refers to the time when the plant gives the most fiber with the least difficulty in decortication. Several tests were conducted to verify whether the varieties had already reached this age. One test was to observe the color of the stem and the condition of the flower clusters. When about one third of the stem from the base upwards had turned brown and one half of the flower clusters had withered, the plant was considered mature. Another test was to pinch off the tip of the plant. When the tip did not cut readily, but instead exposed a number of strong fiber strands, the plant was taken as harvestable. A confirmatory test was likewise conducted which consisted of bending the stem 20 cm. from the ground. When no sound was produced and the wood did not break apart, the plant was regarded as having attained the harvestable age; but if the bending caused the wood to break, then the plant was considered overmature. Signs of overmaturity, such as the browning of one half of the stem upwards and the sprouting of the dormant buds on the stem into branches, were carefully observed.

In average number of days required by the different varieties to attain maturity in the first cutting, it was noted that Saikeiseisin matured earliest, in only 65.6 days. Guiran Taipan No. 1 and Formosa matured in about the same time, in 78.9 and 79.4 days, respectively. Kogai matured last, in 94.0 days. Analyzed statistically, Saikeiseisin matured significantly earlier than any of the other varieties (table 3a). Guiran Taipan No. 1 and Formosa matured in practically the same time, but both matured much earlier than Kogai.

As to the mean maturity periods of the four varieties in the second cutting, it was observed that Saikeiseisin matured earliest in 65.2 days, followed by Guiran Taipan No. 1 and Formosa which matured in 80.8 and 80.9 days, respectively. Kogai matured last, in 91.1 days. As in the first cutting, Saikeiseisin matured much earlier than any of the other varieties. Guiran Taipan No. 1 and Formosa showed no significant difference although both matured earlier than Kogai (table 3b).

Thus, in both the first and second cuttings as regards the flowering period, Saikeiseisin again was earliest, followed by Guiran Taipan No. 1 and Formosa, while Kogai was last. It was also observed that Saikeiseisin was the earliest to attain maturity from the time of full bloom, requiring 18.4 days for the first harvest and 18.0 for the second. Guiran Taipan No. 1 needed 18.8 days to mature in the first planting and 19.3 in the second; Formosa, 20.3 days for the first and 21.8 for the second; and Kogai, 21.6 days for the first and 21.2 for the second. The mean period for all the varieties to reach harvestable age from full flowering was 19.7 days for the first cutting and 20.0 days for the second.

The above-mentioned maturity periods of Saikeiseisin and Guiran Taipan No. 1 fall within the range reported by previous investigators. Capili and Evangelista [10] reported that Saikeiseisin matured in 42 to 65 days. David (1939) stated that in Davao, Saikeiseisin matured in 60 days. According to Cruz, [11] Saikeiseisin matured in 65 days, and Guiran Taipan No. 1 in about 80 days. Jamias [12] reported that Saikeiseisin attained maturity in 60 to 75 days, and Guiran Taipan No. 1 in 75 to 85 days.

The time required for the attainment of maturity is an important consideration in the choice of a variety for commercial planting because on it will depend the number of cuttings that may be made a year. Based on the maturity data obtained, it will be seen that under the same soil and climatic conditions, five or six crops a year may be expected with Saikeiseisin, four or five with either Guiran Taipan No. 1 or Formosa, and only three or four cuttings with Kogai.

Height of plants

The comparative mean heights of mature plants immediately prior to the first cutting were determined. Guiran Taipan No. 1 with a mean height of 122.03 cm. ranked first, followed by Kogai with 121.75 cm., then by Formosa with 108.30 cm. Saikeiseisin was last with only 94.35 cm. Analyzed biometrically, Guiran Taipan No. 1, Kogai, and Formosa showed no significant differences in height (table 4a), but Guiran Taipan No. 1 and Kogai were taller than Saikeiseisin; Formosa and Saikeiseisin, however, had the same mean heights.

A study of the average heights attained by the four varieties during the second cutting showed that Kogai was tallest with 67.50 cm., followed by Guiran Taipan No. 1 with 66.49 cm., then by Formosa with 61.60 cm., and finally by Saikeiseisin with 57.26 cm. When statistically compared (table 4b) the means showed a signi-

[10] CAPILI, A. R. and A. P. EVANGELISTA, 1947. The ramie industry in Davao. Agric. Comm. and Ind. Life 9 (11): 13, 30.

[11] CRUZ, E. E., *op cit.*

[12] JAMIAS, J. *op. cit.*

ficant difference between the varieties. Kogai, Guiran Taipan No. 1, and Formosa were found not to vary significantly in height; but Kogai and Guiran Taipan No. 1 were taller than Saikeiseisin. Formosa and Saikeiseisin did not show any difference in height.

In both the first and second cuttings, Saikeiseisin did not quite attain the range reported in literature. Cruz [13] mentioned Saikeiseisin's attaining a height ranging from 100 to 200 cm. Jamias [14] wrote that Saikeiseisin plants grow to a height of 100 to 175 cm. These authors did not mention the conditions under which such heights were obtained. According to Capili and Evangelista, [15] the height of Saikeiseisin plants varies from three feet (91.44 cm.) in barren and depleted soil to nine feet (274.32 cm.) in very rich soil. It will be seen that Saikeiseisin in the first cutting with a mean height of 94.35 cm. compares well with the height reportedly attained in Davao of plants of the same variety in barren and depleted soil.

Statistically, the four varieties had the same rankings in the first and second cuttings; however, the heights of the plants in the second cutting were about 40 per cent less than those in the first cutting (tables 4a and 4b). A variety of causes may be responsible for this discrepancy. During the period after the first cuting, six typhoons passed over the Experiment Station. Owing to the existence of an adobe pan several centimeters from the surface of the ground, the plots often remained flooded days after the typhoons had passed, thereby adversely affecting the plants. Although the preceding typhoons did not visibly affect the plants, the typhoon "Jean" of December 26, 1947, was very destructive. The plants were either partially defoliated or blown down. A third cause of the very poor showing of the second cutting was the exhausted condition of the soil. Although the refuse of the previous cutting was returned to the field for its manurial value, it is very probable that this manuring was inadequate to compensate the exhausting effect of the first crop on the soil. A symptom indicative of the poor condition of the soil and the unfavorable climatic environment was the prevalence of the leaf spots caused by *Cercospora* sp. during the second crop.

As far as height is concerned, Guiran Taipan No. 1 and Kogai ranked first, followed by Formosa, and finally by Saikeiseisin.

Stooling habit

In average number of stools to a hill of the four varieties during the first cutting, Formosa produced the greatest number of stools in the hill with 9.86, closely followed by Saikeiseisin

[13] CRUZ, E. E., *op. cit.*
[14] JAMIAS, J. *op. cit.*
[15] CAPILI, A. R. and A. P. EVANGELISTA, *op. cit.*

with 8.69. Kogai with an average of 6.73 stools a hill was third, and Guiran Taipan No. 1 with only 4.73, last. When the stooling data were analyzed statistically, it was found that no significant difference existed either between Saikeiseisin and Formosa or between Kogai and Guiran Taipan No. 1; however, Saikeiseisin and Formosa produced more stalks than either Kogai or Guiran Taipan No. 1 (table 5a).

In mean number of stools in the hill during the second cutting, Formosa stooled most with an average of 9.89 a hill, followed by Saikeiseisin with 9.41, and finally by Guiran Taipan No. 1 and Kogai with 7.68 and 7.61, respectively. A highly significant difference was obtained among the varieties. No difference, however, was obtained between Formosa and Saikeiseisin or between Guiran Taipan No. 1 and Kogai, but Formosa and Saikeiseisin stooled more than either Guiran Taipan No. 1 or Kogai (table 5b).

The results showed that stooling seemed to be generally more profuse during the second cutting. This was probably due to the mother rootstocks' being older and better established, and hence more prolific in the production of stalks.

In point of stool production, the varieties had the same rankings in the first and second cuttings. Saikeiseisin and Formosa were first, followed by Kogai and Guiran Taipan No. 1.

Branching tendency

In regard to the number of branching stalks in a plot of 33 hills prior to the first cutting, it was noted that Formosa produced the greatest number of branching stalks with 31.8 a plot of 33 hills, followed by Kogai with 30.9, then by Guiran Taipan No. 1 with 28.5, and lastly by Saikeiseisin with 25.4.

In mean number of branching stalks in a plot of 33 hills prior to the second harvest, Kogai branched most with 7.3 branching stalks a plot of 33 hills, followed by Formosa with 5.9, then by Guiran Taipan No. 1 with 5.3. Saikeiseisin branched least with only 4.3.

In both the first and second cuttings, no significant difference was observed between varieties (tables 6a and 6b). The present data are in conformity with the observations of Cruz,[16] and Jamias,[17] who reported that Saikeiseisin plants are erect and seldom branch out.

The dissimilarity in environmental conditions probably accounted for the discrepancy in the number of branching stools observed in the first and second cuttings. Apparently, the unfavor-

[16] Cruz, E. E. 1946, *op.cit.*
[17] Jamias, J. 1946, *op cit.*

able soil and climatic conditions prevailing during the second cutting tended to inhibit the production of branches.

It must be emphasized here that ramie is a branching plant, that ultimately when full and complete maturity is attained the buds on the stem will germinate and send out branches. What is important from the agronomic point of view, however, is how many plants will bear branches before the harvestable age is reached. Straight, unbranched stems are very much desired in ramie varieties because the existence of branches in a stem causes a discontinuation of the fiber strands at the junction of the main stem and the branch, thereby weakening that point and causing the easy breaking of the fiber strands during decortication.

Analysis of fresh stalks

The comparative weights and percentages of the various constituents of the fresh, undefoliated stalks of each of the four varieties were determined. Table 7 shows that the fresh stems of Saikeiseisin and Formosa had the heaviest weights, 79.07 and 78.63 grams, respectively. Kogai and Formosa weighed much less, 70.28 and 69.25 grams, respectively. The fresh stalks were first analyzed into leaves and flowers, and defoliated stalks or stems. In all the varieties except Kogai, the leaves represented more than one half of the total weight of the fresh stalks, indicating that the plants were in a state of vegetative luxuriance. The percentages of the other component, the defoliated stalk or stem, varied from 52.65 per cent in Kogai to as low as 42.96 per cent in Saikeiseisin, indicating that the stem is the lesser major component of the fresh stalk. The defoliated stalk, which is composed of the wood and the bark with fibrous tissue, was next analyzed. In all the varieties, the wood was roughly one third of the weight of the entire stalk. The percentages of the bark constituent of the stalk ranged from as high as 15.80 in Kogai to as low as 12.33 in Guiran Taipan No. 1. The bark consists of the pulp and the stripped wet fiber. The percentage of the pulp constituent was very variable. Kogai had the highest with 10.46 per cent, followed closely by Formosa and Guiran Taipan No. 1 with 9.30 per cent and 9.12 per cent, respectively, while Saikeiseisin had the lowest with 6.69 per cent. An examination of the percentages of the bark and fibrous tissues and the wet stripped fiber constituents of the stalk showed that Saikeiseisin had the highest percentage of wet stripped fiber (6.05 per cent), based on the weight of the bark with fibrous tissues, which was almost one half of the bark percentage (12.74 per cent). The wet stripped fiber content of Formosa was 5.99 per cent, and that of Kogai 5.34 per cent, in each case forming approximately one-third of the bark constituent. Guiran Taipan No. 1 had the least wet stripped fiber content. Its 3.21 per cent was only one fourth of the percentage of the bark. The wet stripped fiber is composed of moisture and the dry fiber content. Formosa had the highest

percentage of dry fiber. The dry fiber percentages of the different varieties are as follows: Formosa, 2.12; Kogai, 1.55; Saikeiseisin, 1.54; and Guiran Taipan No. 1, 1.10.

Thus, although the fresh stalks of Formosa and Kogai had the least weight among the varieties, this disadvantage is compensated for by their possessing the highest percentages of fiber; and although the fresh stalks of Saikeiseisin and Guiran Taipan No. 1 weighed the heaviest, this advantage is somewhat offset by their possessing lower percentages of dry fiber. On both actual weight and percentage bases, Formosa ranked first as far as dry-fiber content was concerned.

Dry-fiber yield

When the mean dry-fiber yields of the different varieties in the first cutting were determined, it was shown that Formosa had the highest average yield of 5.202 grams a hill, followed by Kogai with 3.612, and by Guiran Taipan No. 1 and Saikeiseisin with 2.613 and 2.493 grams, respectively. The figures, analyzed statistically, (table 8a) showed a highly significant difference among varieties, but no difference was noted between Formosa and Kogai, between Saikeiseisin and Guiran Taipan No. 1, between Kogai and Guiran Taipan No. 1, and between Kogai and Saikeiseisin. However, Formosa gave a significantly higher yield then either Saikeiseisin or Guiran Taipan No. 1.

In dry-fiber yield in grams to the hill of the four varieties in the second cutting, it was shown again that Formosa ranked highest in average yield with 5.295 grams, followed by Kogai with 3.492 grams. Guiran Taipan No. 1 and Saikeiseisin gave the least yields with 2.471 and 2.231 grams, respectively. When the data obtained were treated statistically (table 8b), it was found that a significant difference existed between varieties. No difference was obtained between Kogai and Formosa. Kogai gave practically the same yield as Saikeiseisin and Guiran Taipan No. 1. No significant variation was noted between Saikeiseisin and Guiran Taipan No. 1, but Formosa gave a higher fiber yield than either Saikeiseisin or Guiran Taipan No. 1.

Based on the mean yield of a hill, Formosa had a computed yield of 3.61 piculs to the hectare in the first cutting and 3.67 in the second; Kogai, 2.50 piculs in the first and 2.42 in the second; Saikeiseisin, 1.73 in the first and 1.54 in the second; and Guiran Taipan No. 1, 1.80 piculs in the first and 1.71 in the second. Compared with the reported yields from different localities, these yields are very satisfactory.[18]

[18] David (1939) reported that in Davao, Saikeiseisin gave a yield of three piculs to a hectare in the first cutting and five piculs to a hectare in the second cutting. Jamias (1946) reported that in Cotabato, the first harvest of the first year gave a yield of 1.5 piculs of dry fiber a hectare, while

In point of dry-fiber yield, therefore, it appears that under prevailing environmental conditions, Formosa ranked first, Kogai next, and Guiran Taipan No. 1 and Saikeiseisin last.

BOTANY

Ramie, *Boehmeria nivea* (L.) Gaudich. has been described by Merrill (1912), Brown (1941), Willis (1919), and many other workers. Crane and Acuña (1946) reported that two principal species of *Boehmeria* are cultivated for fiber, namely: *B. nivea*, distinguished by its large cordate leaves (fig. 1) which are very white and tomentose on the undersurface; and *B. utilis* Blume, which is characterized by its more robust habit, with leaves that are green on both surfaces. These authors further reported another species of *Boehmeria* growing in Cuba, *B. japonica* (L.) Miquel, which possesses oppositely arranged leaves as contrasted with the alternately arranged leaves of *B. nivea* and *B. utilis*. Chevalier (1927) observed that *B. nivea* and *B. utilis* appeared to include many varieties but that no systematic study of these had ever been made. Dewey (1943) described the flowers of ramie as small, green or greenish yellow, borne in two clusters on the same stalk (fig. 2), the staminate flowers below (fig. 3, upper, left), scattered in the axils of the leaf stem, and the pistillate flowers (fig. 3, upper, right and lower three figures) above. No systematic study has yet been conducted on the varieties used in this work.

On attaining maturity, the plants of each variety were examined for their external morphological characters. The inflorescence was studied under a dissecting microscope. The prominent external characters of the plants were studied, and the salient features which may serve to distinguish one variety from another are embodied in the following key.

Key for the separation of the varieties used

1. Stem green when young
   a. Petiole green throughout; nether surface of lamina silvery; leaf apex long (fig. 1, upper panel, left). Pistillate flower perianth green, pyriform (fig. 3, left) ..... SAIKEISEISIN
   b. Petiole greenish brown throughout; nether surface of lamina white; leaf apex short (fig. 1, lower panel, right). Pistillate flower perianth green, ovate (fig. 3, lower center) ..... KOGAI

---

the second harvest gave two to four piculs a hectare. Cruz (1946) stated that disregarding the preliminary cutting, which is actually the first cutting in this work, a yield of five piculs a hectare is considered fair for the first harvest, which is equivalent to the second cutting in this project. Jamias (1946), David (1939), Cruz (1946), and Capili and Evangelista (1947) reported that the first cutting of ramie is not decorticated but is left between the rows to rot owing to the low percentage of fiber of the plants.

2. Stem pinkish when young

   a. Petiole pink throughout. Pistillate flower perianth pink, obovate; stigma long (fig. 3, lower left) ..... GUIRAN TAIPAN No. 1.

   b. Petiole pink at ends and lower surface. Pistillate flower perianth green, ventricose with prominent base; stigma short (fig. 3, lower right) ..... FORMOSA

Fig. 3 — Flowers of the four varieties of ramie. Upper figures, left, the staminate flower, identical in all varieties; right, the pistillate flower of Saikeiseisin. Lower figures, left to right, the pistillate flowers of Guiran Taipan No. 1, Kogai, and Formosa. About ×15.

SUMMARY

1. One month after planting, from 73.0 to 82.5 per cent of the roostocks of the four varieties had growing shoots.

2. Owing to unfavorable environmental conditions, the plants in the second cutting appeared poor in condition compared with the plants in the first cutting.

3. Although the damage was not serious, the varieties without exception were attacked by Cercospora leaf spot and the larvae of *Plusia chalcytes* Esper. and *Sylepta sabinusalis* Walker.

4. Saikeiseisin flowered earliest, followed by Guiran Taipan No. 1 and Formosa, while Kogai bloomed latest.

5. Based on the average number of days required to attain maturity, Saikeiseisin may give five or six cuttings a year, Guiran Taipan No. 1 and Formosa four or five, and Kogai only three or four.

6. From the standpoint of height of plants, Guiran Taipan No. 1 ranked first, Kogai second, Formosa third, and Saikeiseisin last.

7. Saikeiseisin and Formosa produced more stalks to the hill than either Kogai or Guiran Taipan No. 1.

8. Before harvesting, all the varieties possessed an insignificant number of branching stalks.

9. An analysis of the fresh stalks of the varieties three and a half months after planting revealed that in point of weight, Saikeiseisin is first for fresh stalks, leaves and flowers, wet stripped fiber, and moisture; Guiran Taipan No. 1 for wood; Kogai for defoliated stalks or stem, bark and fibrous tissues, and pulp (waste); and Formosa for dry fiber.

10. Based on the computed dry-fiber yield to the hectare, the rankings of the varieties for both first and second cuttings are: Formosa first, Kogai second, Guiran Taipan No. 1 third, and Saikeiseisin last.

11. Given the same cultural treatment and environmental conditions, Formosa should be preferred for commercial plantings to any of the other varieties studied.

12. Botanically, the salient distinguishing characters of the different varieties are as follows:

a. Saikeiseisin: leaves exceptionally silvery on nether surface, petioles green throughout entire length, leaf apex long and sharply acuminate, pyriform perianth and long stigma of pistillate flowers.

b. Guiran Taipan No. 1: pink and obovate perianth and long stigma of pistillate flowers, pinkish coloration of stem when young as well as the entire petioles.

c. Formosa: ventricose perianth with prominent base of pistillate flowers; pinkish coloration of immature stems, extreme ends, and nether surface of petioles.

d. Kogai: green, ovate perianth, and long slender stigma of pistillate flowers, brownish-green petioles.

LITERATURE CITED

BROWN, W. H. 1941. Useful plants of the Philippines. Vol. I. (p. 483-484). Manila: Bureau of Printing.

CHEVALIER, A. 1927. Ramie from the botanical point of view. Fibre and Fabric. 80: 6, 8, 10, 12. *Cited in* Jour. Amer. Soc. Agron. 38 (2): 153.

CRANE, J. C., AND J. B. ACUÑA, 1946. A comparative evaluation of fourteen types of ramie under Cuban conditions. Jour. Amer. Soc. Agron. 38 (2): 152-167.

DAVID, P. A. 1939. Ramie and its cultivation in Davao. Philippine Agriculturist 28: 28-43.

DEWEY, L. H. 1943. Fiber production in the western hemisphere. U. S. Dept. Agric. Misc. Pub. 518: 74-79.

MERRILL, E. D. 1912. A flora of Manila. 490 p. Manila: Bureau of Printing. (p. 179-181).

NELLER, J. R. 1945. Culture, fertilizer requirements, and fiber yields of ramie in the Florida Everglades. Florida Agric. Exper. Sta. Bull. 412.

WILLIS, J. C. 1919. A dictionary of flowering plants and ferns. 4th ed. xii + 712 + liv. p. Cambridge: Cambridge University Press. (p. 85, 672).

TABLE 1

Analysis of variance of the percentages of germination of rootstocks of the four varieties

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	569.50	189.83	2.58	2.96	4.60
Plots	9	1210.00	134.44	1.69	2.25	3.14
Error	27	1985.50	73.53			
Total	39	3765.00				

Not significant

TABLE 2a

Analysis of variance of the number of days required by the four varieties to attain full flowering in the first cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	3181	1060.3	39.1	2.96	4.60
Plots	9	436	48.4	1.7	2.25	3.14
Error	27	734	27.1			
Total	39	4351				

L.S.M.D. — 4.7196

TABLE 2b

Analysis of variance of the number of days required by the four varieties to attain full flowering in the second cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	2636	878.6	66.56	2.96	4.60
Plots	9	338	37.5	2.86	2.25	3.14
Error	27	357	13.2			
Total	39	3331				

L.S.M.D. — 3.32424

TABLE 3a

Analysis of variance of the number of days required by the four varieties to attain maturity in the first cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	4038	1346.0	43.1	2.96	4.60
Plots	9	623	69.2	2.2	2.25	3.14
Error	27	845	31.2			
Total	39	5506				

L.S.M.D. — 5.1300

TABLE 3b

Analysis of variance of the number of days required by the four varieties to attain maturity in the second cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties.	3	3427	142.3	10.09	2.96	4.60
Plots	9	331	36.7	2.60	2.25	3.14
Error	27	382	14.1			
Total	39	4140				

L.S.M.D. — 3.42684

TABLE 4a

Analysis of variance of the average height in centimeters of mature plants prior to the first cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	5,202.59	1,734.19	4.20	2.96	4.60
Plots	9	5,927.94	658.66	1.59	2.25	3.14
Error	27	11,130.53	412.24			
Total	39	17,426.79				

L.S.M.D. — 18.63216

TABLE 4b

Analysis of variance of the average height in centimeters of mature plants prior to the second cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	669.19	223.06	2.96	2.96	4.60
Plots	9	2,644.06	293.78	3.88	2.25	3.14
Error	27	2,043.21	75.67			
Total	39	5,356.46				

L.S.M.D. — 7.98228

TABLE 5a

Analysis of variance of the average number of stalks per hill in the first cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	177.04	59.01	18.38	2.96	4.60
Plots	9	45.94	5.10	1.58	2.25	3.14
Error	27	86.78	3.21			
Total	39	309.76				

L.S.M.D. — 1.6416

TABLE 5b

Analysis of variance of the average number of stalks per hill in the second cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	41.37	13.17	5.95	2.96	4.60
Plots	9	49.47	5.49	2.48	2.25	3.14
Error	27	59.78	2.21			
Total	39	150.62				

L.S.M.D. — 1.35432

TABLE 6a

Analysis of variance of the number of branching stalks per plot of 33 hills prior to the first cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	245.7	81.9	0.57	2.96	4.60
Plots	9	1982.1	220.8	1.54	2.25	3.14
Error	27	3857.3	142.8			
Total	39	6085.1				

Not significant

TABLE 6b

Analysis of variance of the number of branching stalks per plot of 33 hills prior to the second cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	47.8	14.4	2.02	2.96	4.60
Plots	9	144.4	16.0	2.25	2.25	3.14
Error	27	192.4	7.1			
Total	39	594.4				

Not significant

TABLE 7

Weights and percentage of fresh stalk constituents of the four varieties[1]

CONSTITUENT	SAIKEISEISIN		GUIRAN TAIPAN NO. 1		FORMOSA		KOGAI	
	grams	*per cent*	*grams*	*per cent*	*grams*	*per cent*	*grams*	*per cent*
Fresh stalk	79.07	100.00	78.63	100.00	69.25	100.00	70.28	100.00
Leaves and flowers	45.78	57.04	41.01	52.15	35.42	51.14	33.28	47.35
Defoliated stalk or stem	33.29	42.96	37.62	47.85	33.83	48.86	37.00	52.65
Defoliated stalk or stem:								
Wood	29.39	30.22	27.93	35.52	23.25	33.57	25.90	36.85
Bark and fibrous tissues:	10.07	12.74	9.69	12.33	10.58	15.29	11.10	15.80
Bark and fibrous tissues:								
Pulp (waste) .	5.27	6.69	7.17	9.12	6.44	9.30	7.35	10.46
Wet stripped fiber	4.80	6.05	2.52	3.21	4.14	5.99	3.75	5.34
Wet stripped fiber:								
Moisture	3.58	4.51	1.66	2.11	2.68	3.87	2.66	3.79
Dry fiber	1.22	1.54	0.86	1.10	1.46	2.12	1.09	1.55

[1] Average of ten hills from ten randomized plots of each variety.

TABLE 8a

Analysis of variance of the average dry-fiber yield in grams per hill for the first cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	47.09	15.69	4.61	2.96	4.60
Plots	9	70.68	7.85	2.31	2.25	3.14
Error	27	91.93	3.40			
Total	39	209.70				

L.S.M.D. — 1.68264

TABLE 8b

Analysis of variance of the average dry-fiber yield in grams per hill for the second cutting

SOURCES OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					5%	1%
Varieties	3	58.26	19.42	3.59	2.96	4.60
Plots	9	87.76	9.75	1.80	2.25	3.14
Error	27	146.02	5.40			
Total	39	214.89				

L.S.M.D. — 2.11356

THE YIELD AND VARIETAL CHARACTERS OF SOME VARIETIES OF THE SWEET POTATO[1]

VALERIANO C. CALMA AND FRANCISCO S. ZAMORA
Of the Department of Agronomy

A study of the yield and varietal characters of some varieties of the sweet potato was conducted from December, 1945, to October, 1946, in the Experiment Station and in the laboratory of the Department of Agronomy, College of Agriculture, Los Baños, Laguna.

In earlier studies on the sweet potato in this college, Merino (1914) found that Samar Big Yellow was the heaviest yielder and the earliest to mature. At the age of five months, it gave an average yield of 1.48 kgm. to the hill. Mendiola (1921) noted variations in Samar Big Yellow of the leaf, yield of tubers, color of the skin, flesh of the roots, and flavor. Muñoz (1914) adopted Groth's formula for identifying and classifying sweet potato varieties.

Mateo R. Alcantara in 1944 studied, under the direction of Dr. José M. Capinpin of the Department of Botany, five Catanduanes varieties of sweet potatoes, three of which were included in the present study; namely, Segurado, Tamisang Puti, and Kadali. In an unpublished manuscript entitled "Test in Yield and Maturity of Catanduanes Sweet Potato," Alcantara stated that the varieties he used in his work were probably hybrids. He found that after 45 days, there was no longer any increase in the number of fleshy roots of Segurado, Kadali, and Tamisang Puti, although the roots continued to increase in size until they were 70 days old. The three varieties gave high yields at the age of 45 to 60 days. Tamisang Puti was recommended by Alcantara for its heavy yield and fine eating quality.

EXPERIMENTS, RESULTS, AND DISCUSSION

The following 11 varieties of the sweet potato were used: the Igorot,[2] Initlog,[3] Kadali, Segurado, Tamisang Puti,[4] Pirurutong,[5]

[1] Experiment Station Contribution No. 1509, based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, November, 1946. Read by the senior author before the Los Baños Biological Club on November 7, 1947.

[2] Secured from Dr. Silverio M. Cendaña of the Department of Entomology. This variety is said to be extensively grown in Mangaldan, Pangasinan.

[3] From the residence of Dr. Francisco M. Fronda on the Faculty Hill, College.

[4] All three — Kadali, Segurado, and Tamisang Puti — were furnished by Mr. Mateo R. Alcantara, who in 1944 performed an experiment on five varieties under the guidance of Dr. José M. Capinpin.

[5] From the School of Forestry.

Samar Big Yellow,[6] Siamese,[7] S.P. 38,[8] which was isolated by Indemne,[9] Sinawa,[10] and Kinalamyas.[11]

A field of clay loam soil about 825 square meters in size was plowed on December 10, 1945, and harrowed the following day. The land was plowed again on December 20, and harrowed immediately after. The third plowing was made on December 29, but because of a heavy rain it was harrowed with a spike-toothed harrow on January 8, 1946.

Tip cuttings of sweet potato vines, 35 to 40 cm. long, were planted 50 cm. apart in furrows one meter from each other; about two-thirds of the cuttings were covered with soil. Fifty cuttings were set in each row and three replications were made for each variety, using a total of 150 cuttings of each variety. The replicated plots were distributed at random. At the extreme end of each row, guard hills were planted. Varieties Kadali, Segurado, Tamisang Puti, S. P. 38, Siamese, Igorot, Initlog, and Samar Big Yellow were planted on January 9, 1946; Kinalamyas, Pirurutong, and Sinawa on January 10; and Samar Big Yellow on January 12.

On January 25, 1946, fifteen days after the planting, the writers noted that in the S.P. 38 row, eight plants had died; in the Igorot, four; in Segurado, three; and in Tamisang Puti, three. These missing hills were replanted with balled plants taken from the guard hills of each variety, which had been reserved for this purpose, care being taken not to injure the plants in the replanting.

The different varieties varied greatly in their growth habits in the field, indicating that the varieties were distinct from each other. Siamese, Pirurutong, Initlog, S. P. 38, and Igorot had the most luxuriant growth; Kadali was the least luxuriant. S.P. 38 and Igorot had the longest internodes, with an average length of vine of 344.0 and 262.0 cm., respectively. Segurado, Tamisang Puti, and Kadali had the shortest vines, with an average vine length of 101.3 cm., 127.0 cm., and 132.0 cm., respectively. Siamese, Initlog, and Pirurutong had big broad leaves and thick stems. Tamisang Puti, Segurado, and Pirurutong produced many branches at the base. Kadali had the least branches. Tamisang Puti, Segurado, and Kadali

---

[6] A well-known variety secured from the U.P. Rural High School.

[7] From Dr. Dioscoro L. Umali of the Department of Agronomy.

[8] Also from Dr. Umali. This was a seedling selection of the Ocagen variety from Bontoc, Mountain Province, which was produced by the Plant Breeding Division of the Department of Agronomy and isolated by Indemne.

[9] INDEMNE, ZORAIDA P. Variation and selection of sweet potato seedlings. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1945. Unpublished.)

[10] From Putho, Los Baños.

[11] From San Antonio, Los Baños.

had shorter internodes than the other varieties. After two months, the vines of all of the varieties covered all the spaces between them so that the knot grass *Cyperus rotundus* Linn., the predominating weed, was properly checked.

Flowering habit

Only the varieties Siamese, Igorot, Samar Big Yellow, and Pirurutong flowered from the age of two months to harvesting time. Samar Big Yellow flowered the most, followed by Pirurutong; Igorot produced the least flowers.

Relative maturity periods

Five hills from the furrow of each variety were dug 50 days after planting and every 15 days thereafter until the end of the experiment. Tamisang Puti, Segurado, and Kadali matured the earliest. They produced marketable roots 50 days from planting. Alcantara found that these three varieties may be dug 45 days after planting. He also stated that after 45 days the fleshy roots did not increase in number but in size. For 45- and 60-day crops, he recommended the varieties Tamisang Puti, Segurado, and Kadali. The writers found Kadali most profitable to harvest 65 days after planting. Segurado and Tamisang Puti reached the maturity stage in 80 to 95 days after planting. Siamese, Initlog, Pirurutong, Kinalamyas, Sinawa, and Samar Big Yellow were ready for harvesting in 80 to 95 days after planting, although Merino (1914) found that Samar Big Yellow gave an average yield of 1.48 kgm. to the hill at the age of five months.

The varieties Igorot and S.P. 38 matured in 110 to 125 days after planting. After 125 days most of the roots of Igorot and S.P. 38 had already been attacked by the sweet-potato weevil *Cylas formicarius* Fabr.

Relative susceptibility to pests

All of the varieties studied were attacked in different degrees by the sweet-potato weevil *Cylas formicarius* Fabr., showing, as Gonzales (1925) reported, that the sweet-potato weevil is destructive to the roots at any time of the year. The writers noted that in the first harvest, 50 days after planting, there was no sign of infestation of the roots. In the second harvest, when the plants were 65 days old, Segurado had 4.87 per cent infestation; Initlog, 5.78; Samar Big Yellow, 9.82; Tamisang Puti, 17.44; Kadali, 20.17; and S.P. 38, 34.42. Eighty days after they were planted, Kinalamyas, Sinawa, Siamese, Igorot, and Pirurutong exhibited the first sign of infestation with weevils as follows: Kinalamyas, 2.58 per cent; Sinawa, 4.96; Siamese, 17.21; Igorot, 25.62; and Pirurutong, 27.04. At the age of 125 days, Pirurutong and S.P. 38 had reached their maximum infestation, with 100 and 85.93 per cent, respectively.

However, 185 days after planting, or at the last digging, these varieties showed 89.4 and 56.08 per cent infestation, respectively. The reason for the diminished infestation was that the plants had formed new fleshy roots which were not infested at all. Segurado and Samar Big Yellow had their maximum infestation at the age of 155 days, with 100 and 95.63 per cent, respectively. On the second to the last digging at 170 days, Igorot, Initlog, Siamese, and Kinalamayas were found to have their roots totally infested. At the last harvest, Sinawa was 100 per cent infested and Tamisang Puti, 97.87 per cent. As a whole, the result showed that all the varieties studied were attacked by the sweet-potato weevil, and as the plants became older, infestation became more severe.

Relative eating quality

At the age of 50 days, only Segurado and Tamisang Puti had roots available for a test of their eating quality. At this age the roots were still immature; they were watery and not sweet. In the second harvest, or 65 days after planting, enough samples from each variety were available. Cooked Pirurutong and Samar Big Yellow were liked best by those who made the test because of the attractive color of the flesh and of the sweeter taste. Tamisang Puti and Segurado vied for second place, but as the plants grew older Tamisang Puti was preferred to Segurado. In subsequent tests the ranking took this descending order: Samar Big Yellow, Pirurutong, Tamisang Puti, and Segurado. The other varieties had practically the same eating quality. They were rated inferior in this respect to the other four varieties. After 125 days some varieties were not edible anymore because the majority of the roots had already been attacked by the sweet-potato weevil. S.P. 38, however, still had plenty of marketable roots at that time. Samar Big Yellow did not show any decrease in palatability up to 185 days after planting.

Description of the varieties

TAMISANG PUTI. Leaves entire, heart-shaped, 8.92 cm. wide, 10.1 cm. long, without hairs. Veins, greenish to white on old leaves, purple on young. Petiole, 7.11 cm. long. Stem, 127.0 cm. long, 0.53 cm. thick; greenish when young, brown to light purple when old, with brownish spots; no star present. Tubers, roundish, becoming elongated as they grow old; skin, pale olive to whitish; flesh, whitish to cream yellow, with no visible wood elements. Flowers, few.

SEGURADO.[12] Leaves broad with slight dentations, 9.12 cm. wide, 6.76 cm. long, without hairs. Veins, greenish to whitish on old leaves, purple on young. Petiole, 9.94 cm. long. Stem, 101.3 cm. long, 0.54 cm. thick, green. No star present. Midribs, greenish in old leaves, pinkish on young. Tubers, roundish with pink skin. Flesh, with blurred wood elements. Flowers, absent.

[12] Alcantara's description of the variety Segurado differs from the writers' in shape of leaves, size of stem, and flowering habits.

SINAWA. Leaves long or heart-shaped, 9.83 cm. wide, 9.9 cm. long, without hairs. Veins, green. Petiole, 9.94 cm. long. Stem, about 169.8 cm. long, 0.58 cm. thick, green. No star present. Midribs, green. Tubers, elongated, irregular in shape; skin, dark Corinthian purple (Ridgway, 1912). Flesh, honey yellow, with no visible wood element. Flowers, absent.

PIRURUTONG. Leaves round, lobed, 13.7 cm. wide, 12.0 cm. long, hairs absent. Veins, greenish on old leaves, light purple on young. Petiole, 11.15 cm. long. Stem, 158.0 cm. long, 0.62 cm. thick, purple, no star present. Midribs, pinkish on young, greenish on old. Tubers, elongate; skin, slate purple. Flesh, deep vinaceous gray, marked with purple linings, with blurred wood element. Flowers, few.

KINALAMYAS. Leaves broad, 9.65 cm. wide and 9.12 cm. long, hairs chiefly along veins. Veins, greenish on old leaves, light purple on young. Petiole, 10.57 cm. long. Stem, 158.0 cm. long, 0.62 cm. thick, pale brown. No star present. Midribs greenish on old leaves, pinkish on young. Tubers elongate to oblong; skin, red purple. Flesh, ivory yellow, with no visible wood element. Flowers, few.

SAMAR BIG YELLOW. Leaves long or heart-shaped, 10.4 cm. wide, 11.15 cm. long, hairs all over. Veins and midribs, green. Petiole, 9.92 cm. long. Stem, 129.1 cm. long, 0.58 cm. thick; pale green to pale brown. No star present. Tubers of somewhat uniform shape, roundish to long. Skin, light buff to yellow. Flesh, light ochraceous salmon, with no distinct wood element. Flowers, profuse.

S.P. 38. Leaves cut, 11.7 cm. wide, 10.39 cm. long, hairs absent. Veins, green to whitish. Petiole, 8.94 cm. long. Stem, 344.0 cm. long, 0.5 cm. thick, green with brownish spots. No star present. Midribs, green. Tubers, roundish. Skin, purple. Flesh, pale yellow to whitish, with blurred wood element. Flowers, very few.

KADALI. Leaves long, heart-shaped, entire, 9.86 cm. long, 9.85 cm. wide, hairs absent. Veins, green. Petiole, 8.62 cm. long. Stem, 132.0 cm. long, 0.47 cm. in diameter, green. No star present. Tubers, elongate. Skin, purplish. Flesh, pale pinkish, with blurred wood element. Flowers, absent.[13]

IGOROT. Leaves cut, 12.32 cm. wide, 11.39 cm. long, hairs absent. Veins, purplish on the neither surface, white on the upper surface of old leaves. Petiole, 9.93 cm. long. Stem, 262.2 cm. in length, 0.56 cm. thick; pale green with purplish spots when old, green when young. No star present. Midribs, absent. Tubers of somewhat uniform shape, roundish to long. Skin, dull white. Flesh, cream yellow, with no visible wood element. Flowers, absent.

INITLOG. Leaves broad, 12.04 cm. wide, 11.99 cm. long, hairs absent. Veins, white to greenish on upper surface, purplish on nether surface. Petiole, 13.37 cm. long. Stem, about 207.6 cm. long, 0.56 cm. thick, green, with brown spots. No star present. Midribs, green to whitish. Tubers, variously shaped, from irregularly elongate to roundish. Skin, golden yellow. Flesh, ochraceous orange to pink. Flowers, absent.

SIAMESE. Leaves broad, 12.04 cm. wide, 11.99 cm. long, hairs absent. Veins, green on old leaves. Petiole, 12.13 cm. long. Stem, 252.3 cm. long, 0.84 cm. thick, green with a light purple spot at base of petiole when young. No star present. Midrib, whitish to greenish. Tubers, elongate and irregularly shaped. Skin, yellow golden or bronze. Flesh, cream-colored or whitish yellow, with no visible wood element. Flowers, few.

[13] According to Alcantara, Kadali bears a few flowers.

In general, the writers observed that size of stem, size of leaves, and size of petiole of the sweet potato are affected by the soil and seasonal conditions. These characters are, therefore, not good bases for separating varieties.

Comparative yield of the different varieties

Fifty days after planting. In the three replications, Segurado and Tamisang Puti were the only varieties that yielded marketable roots 50 days after planting. The rest either had only very few, small, and fibrous roots, or none at all. The analysis of variance of the two varieties shows that the means of both the variety and the replication had insignificant differences.

Sixty-five days after planting. Seven varieties produced marketable roots in the three replications 65 days after planting. Samar Big Yellow, Sinawa, S.P. 38, and Igorot were not used in the statistical computation because they did not have roots. The analysis of variance showed that the variety variance was highly significant. The replication, however, contributed nothing to the differences in the yields of the varieties. Each of Segurado, Kadali, Pirurutong, and Tamisang Puti gave a significantly higher yield than any one of Siamese, Initlog, or Kinalamyas. There were no significant differences among the yields of Segurado, Kadali, Pirurutong, and Tamisang Puti. Likewise, there were no significant differences in the yields of Siamese, Initlog, and Kinalamyas.

Eighty days after planting. All varieties produced marketable roots 80 days after planting. Tamisang Puti was the highest producer, giving significantly higher yields than any of the other varieties studied. Sinawa, Pirurutong, and Segurado ranked second, with no significant differences among their means. Each of these three varieties, however, gave significantly higher yields than any of the remaining varieties, which had no significant difference in their yields, although Kadali, which matures in 45 to 60 days, gave the lowest yield.

Ninety-five days after planting. With the exception of Igorot and Kadali, all varieties had their maximum yield at the age of 95 days. Igorot produced its highest yield 110 days after planting. Tamisang Puti outyielded significantly each of the other varieties. Kinalamyas ranked second with a significantly higher yield than Kadali, Siamese, Initlog, S.P. 38, or Segurado, although its yield did not differ significantly from those of Sinawa, Pirurutong, Samar Big Yellow, and Igorot. The yields of the rest of the varieties did not differ significantly.

One hundred ten days after planting. At the age of 110 days only seven varieties were studied statistically. Pirurutong, Kadali, and Samar Big Yellow had the majority of their roots infested with the sweet-potato weevil. At this age Tamisang Puti gave a signi-

ficantly higher yield than Segurado, Sinawa, S.P. 38, Initlog, and Siamese. Segurado, Sinawa, S.P. 38, Igorot, Initlog, and Siamese had insignificant differences in yield. Siamese gave the lowest yield.

One hundred twenty-five days after planting. Sinawa, Pirurutong, Kinalamyas, Samar Big Yellow, Kadali, Initlog, and Siamese were not included in the statistical studies 125 days after planting because the majority of their roots had been infested with root weevil and were not marketable. Tamisang Puti, Segurado, S.P. 38, and Igorot, however, gave no significant differences in their yields 125 days after planting.

One hundred forty to one hundred eighty-five days after planting. In 140 to 185 days after planting, the majority of the roots of the different varieties had rotted. On the basis of the actual weight of the marketable roots, S.P. 38 gave the highest yield 140 days after planting; the rest had but very few marketable roots, and Igorot had 100 per cent of weevil infestation. In total yield, Tamisang Puti was still the highest. Segurado, Kadali, S.P. 38, and Sinawa were still producing marketable roots 170 days after planting. Igorot, Samar Big Yellow, and Pirurutong had marketable roots 185 days after planting, with S.P. 38 giving the highest yield.

Grouping of the varieties on the basis of maturity period

Varieties ready for harvesting 65 to 80 days after planting and considered early maturing were Kadali and Segurado; those ready in 80 to 110 days after planting and considered medium maturing were Tamisang Puti, Pirurutong, Sinawa, Igorot, Samar Big Yellow, Siamese, Initlog, and Kinalamyas. S.P. 38, which required 140 days, was late maturing.

SUMMARY

1. Eleven varieties of the sweet potato, namely, Siamese, Igorot, Initlog, Segurado, Tamisang Puti, Pirurutong, Kinalamyas, Kadali, S.P. 38, Sinawa, and Samar Big Yellow, were studied for yield and varietal characters.

2. Siamese was the most vigorous, followed by Initlog and Samar Big Yellow. The rest exhibited luxuriant growth, but they were not as rank growers as the first three varieties.

3. Kadali and Segurado were ready for harvesting 65 to 80 days after planting. The varieties Tamisang Puti, Pirurutong, Sinawa, Igorot, Samar Big Yellow, Siamese, Initlog, and Kinalamyas matured more slowly and were not ready for harvesting until after 80 to 110 days from planting. S.P. 38 matured in 140 days.

4. On the basis of yield of marketable roots, the six varieties ranked in descending order as follows: Tamisang Puti, 95 days

after planting; Segurado, 180 days; Sinawa, Pirurutong, Kinalamyas, and Samar Big Yellow, 95 days.

5. In eating quality 95 days after planting, Samar Big Yellow outranked the rest, followed by Pirurutong, and Tamisang Puti. The others were also good, although they were not so pleasant to the taste as the other three varieties.

6. Considered on the basis of both yield and eating quality of the roots at the age of 95 days, the first six varieties ranked in descending order are as follows: Tamisang Puti, Pirurutong, Samar Big Yellow, Segurado, Sinawa, and Kinalamyas.

7. All varieties were attacked by the sweet-potato weevil *Cylas formicarius* Fabr., but in varying degrees. The following varieties were least affected: Tamisang Puti, S.P. 38, Sinawa, Segurado, and Samar Big Yellow. Sweet potato should be harvested as soon as it is mature to minimize weevil damage.

LITERATURE CITED

GONZALES, SALUSTIANO S. 1925. The sweet potato weevil (*Cylas formicarius* Fabr.) Philippine Agriculturist **14**: 257-282.

MENDIOLA, N. B. 1921. Two years of sweet potato breeding. Philippine Agriculturist **10**: 179-187.

MERINO, G. F. 1914. Field test of sweet potato. Philippine Agriculturist and Forester **3**: 146-156.

MUÑOZ, A. R. 1914. Identification and test of sweet potato. Philippine Agriculturist and Forester **3**: 131-133.

RIDGWAY, R. 1912. Color standards and color nomenclature. 43 p., 53 col. pl. Washington, D.C. A. Hoen and Company.

ANALYTICAL STUDIES OF REXORO, NIRA, AND IOLA RICE VARIETIES GROWN IN THE COLLEGE OF AGRICULTURE [1]

José M. Capinpin and Gregorio B. Miguel
Of the Department of Agricultural Botany

WITH ONE TEXT FIGURE

Early in 1946, the College of Agriculture received from Jenkin W. Jones, principal agronomist and rice breeder of the United States Department of Agriculture, a few grams of seeds of the Rexoro, Nira, and Iola varieties of rice. According to him, these commercial rice varieties of the United States, which were among those sent to the Philippines as relief cereals from the UNRRA immediately after liberation, were isolated from varieties originally introduced from the Philippines. Preliminary trials of these varieties conducted by the senior author indicated that they are adapted to conditions in the College of Agriculture and show promise of being worthy of further observation. With the aim of developing them into commercial varieties, plantings were made in the experimental lots of the Department of Agricultural Botany and the behavior of the plants studied from April, 1947, to January, 1948.

Rexoro, Nira, and Iola are pure-line selections made by Charles E. Chambliss and J. Mitchell Jenkins [2,3] in the co-operative experiments at the Rice Experiment Station at Crowley, Louisiana, from varieties introduced by the United States Department of Agriculture from the Philippines. These three varieties have been developed and thoroughly tested in the United States Department of Agriculture rice experiment stations at Crowley, Louisiana; Beaumont, Texas; and Stuttgart, Arkansas. Rexoro was selected in 1926 from the Marong-Paroc variety introduced in 1911; Nira, in 1928, from an unnamed variety introduced in 1916; and Iola, in 1926, from the Finindoc variety introduced in 1916. Rexoro was released for commercial growing by the Department in co-operation with the Louisiana Experiment Station in 1928, Nira in 1932, and Iola in 1931.

Rexoro, Nira, and Iola are all late-maturing, and have long slender grains that yield and mill well. Both Rexoro and Iola are resistant to Cercospora leaf spot disease and have good table quality, that of Rexoro being very good.

---

[1] Experiment Station Contribution No. 1510, based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1948.

[2] Jones, J. W. 1936. Improvement in rice. U.S. Dept. Agric. Yearbook of Agriculture. pp. 415-454.

[3] Jones, J. W. 1941. Rice varieties and their comparative yields in the United States. U.S. Dept. Agric. Cir. 612: 1-34.

The acreage of Rexoro covers the states of Louisiana and Texas. In 1935 about 1.92 per cent of the rice produced in the United States consisted of this variety. Nira has been attracting the attention of the producers and millers in Louisiana, Texas, and Arkansas. Its acreage was materially increased in 1935 when it made up 0.27 per cent of the total rice produced in the United States. The acreage of Iola was confined in the state of Louisiana.

EXPERIMENTS, RESULTS, AND DISCUSSION

Preparation of seedbeds. Three seedbeds were prepared, one for each variety, at the back of the Department of Agricultural Botany, where water was available at any time of the day. The soil was saturated with water as in an ordinary seedbed. On July 12, 1947, a handful of the rice seeds of each variety in cloth bags was soaked in running water for 24 hours, removed from the water, incubated for another 24 hours and then broadcast, one variety to a seedbed. In the field, irrigation water was supplied during the period of growth of the seedlings. The seeds germinated five days after sowing. The seedlings were uniform in height and in color. They were free from pests and diseases.

Planting in the paddies. On August 25, 1947, or exactly 42 days after sowing in the seedbeds, the seedlings were pulled and pruned, leaving two thirds of the leaves to minimize transpiration. The seedlings were planted in hills 25 centimeters apart, one plant to a hill. One week after transplanting, enough water was maintained in the paddies to simulate the conditions in lowland rice culture. Tillers began to appear two weeks after the seedlings were transplanted. Water was drained off whenever necessary and was completely withdrawn from the paddies when the plants were nearing maturity.

Period of growth. Weeding by hand was done whenever necessary until the plants were in the booting stage. The occurrence of frequent strong winds in the months of August, October, and November, 1947, did not affect the stand of the crop but interfered with the flowering, as some plants failed to flower. Flowering was observed in all varieties 98 days after sowing and continued to 109 days for Rexoro and 113 days for Nira and Iola. The subsequent strong winds that came on October 31 and November 15 to 16, 1947, affected more the development of the grains in Nira than in Rexoro and Iola.

Maturity of the grains in Rexoro was observed when the plants were from 119 to 131 days of age; Iola, 121 to 133 days; and Nira, 122 to 134 days.

Susceptibility to plant pests and diseases. Pests and diseases were observed from the booting stage to maturity of the plants. The most serious pest was the red rice weaver, *Lonchura ferruginosa*

jagori Martens, which came in groups, especially in the morning. The presence of the birds was noted as early as the milk stage and continued till the grain matured. The damage was minimized with the use of scarecrows. Another pests is the rice stem borer, *Schoenobius incertellus* Walker, but its damage was slight in comparison with that of the rice bug, *Leptocorisa acuta* Thunberg. The latter was second to the rice weaver in destructiveness. It was controlled by hand picking. Least affected by these pests was Rexoro and the most affected was Nira. The weevil *Sitophilus oryzae* Linn. was observed attacking the grains in the mature stage, affecting Rexoro the least and Nira the most. The leaf spot disease *Cercospora oryzae* Miyake was observed on a few plants of Nira, but the disease did not cause any appreciable damage to the plants.

Analytical study of morphological characters

Presence or absence of pigments.[4] The three varieties of rice varied slightly in their external appearance. Their leaf sheaths were yellow green to calliste green. The pigments of their internodes were chrysolite green to deep sea-foam green. The glume was chamois-colored in the Rexoro variety and warm buff in Nira. In Iola, the glume was cream buff. In varieties Rexoro and Iola the color of the glume tip was similar to that of their glumes, while in the variety Nira the glume tip was buckthorn brown. There was only a slight variation in the color of the flag leaf of the three varieties, the color varying from mineral green to calliste green. The kernels of Nira and Iola were light buff, while those of Rexoro were cartridge buff.

Habit and length of straw, and shattering characteristics. The straw in all varieties did not vary in habit; all were erect. Although strong winds occurred, none of the varieties lodged. Rexoro was not of the shattering type, while Iola shattered grains easily.

Plant height, leaf length, and leaf width

Plant height. The means of the height of 50 plants of each variety, measured from the base to the tip of the flag leaf, ranged from 124.46 $\mp$ 0.776 centimeters in the Rexoro variety to 135.98 $\mp$ 0.810 centimeters in the Nira variety. Iola had a mean height of 133.46 $\mp$ 0.865 centimeters. Statistical comparison of the means revealed that the difference between the highest mean (Nira) and the lowest (Rexoro) was highly significant. Similarly, the difference between the second highest mean (Iola) and the lowest was also highly significant. The difference between the highest mean and the second highest was significant.

[4] The colors of the pigments in the plant and grains were based on RIDGWAY, R. 1912. Color standards and color nomenclature, iii + 42 p., *53 plates.* Washington, D.C.: A. Hoen and Company.

The results of the writers' study compare favorably with the comparative tests of plant height of the three varieties made by Jones in 1941 at the Rice Branch Experiment Station, Stuttgart, Arkansas; at the Rice Experiment Station, Crowley, Louisiana; and at Agricultural Substation No. 4, Beaumont, Texas. In these tests the variety Nira was the tallest, with a height of 129 cm., Iola ranked second with a height of 123 cm., and Rexoro ranked third with a height of 114 cm.

Length of leaves. The means of the leaf length varied from 30.05 $\mp$ 0.404 cm. in Rexoro to 39.29 $\mp$ 0.475 cm. in Nira. Iola obtained a mean of 38.36 $\mp$ 0.534 cm. The difference between the highest mean (Nira) and the lowest (Rexoro), and that between the second highest mean (Iola) and the lowest were highly significant, but that between the highest mean and the second highest was not significant.

Width of leaves. The means of the width of the leaves were 1.82 $\mp$ 0.029 cm. in Rexoro, 1.94 $\mp$ 0.030 cm. in Iola, and 2.03 $\mp$ 0.031 cm. in Nira. There was a highly significant difference between the highest mean (Nira) and the lowest (Rexoro) and between the second highest mean (Iola) and the lowest. The difference between the highest mean and the second highest was significant.

It is interesting to note that Nira leads the three varieties in all the plant characters studied. There existed no marked difference between the Nira and Iola varieties. The variations noted between either Nira or Iola and Rexoro were in plant height, length of leaves, and width of leaves.

Flowering and maturity

Number of days from sowing to flowering. The means of the number of days from sowing to flowering of the three varieties were 102.62 $\mp$ 0.396 in Rexoro, 106.10 $\mp$ 0.529 in Iola, and 106.22 $\mp$ 0.500 in Nira. The difference between the highest mean (Nira) and the lowest (Rexoro) and that between the second highest mean (Iola) and the lowest were highly significant, whereas that between the highest mean and the second highest mean was not significant.

Number of days from sowing to maturity. The means of the number of days from sowing to maturity ranged from 124.58 $\mp$ 0.472 in Rexoro to 127.50 $\mp$ 0.430 in Nira, Iola coming a close second with a mean of 127.06 $\mp$ 0.455. The difference between the highest mean (Nira) and the lowest (Rexoro) and that between the second highest mean (Iola) and the lowest were highly significant. On the other hand, the difference between the highest and the second highest was not significant.

The writers' figures on the maturity of these three varieties differ markedly from those obtained by Jones in 1941; in the latter, Rexoro matured in 177 days, Iola in 167, and Nira in 153 days.

Tillering capacity

Number of tillers.[5] Rexoro had a mean number of tillers of 6.95 $\mp$ 0.172, Nira 7.25 $\mp$ 0.228, and Iola 7.77 $\mp$ 0.232. The difference between the highest mean (Iola) and the lowest (Rexoro) was highly significant. On the other hand, the difference between the highest mean and the second highest (Nira) was not significant; neither was the difference between the second highest mean and the lowest.

Number of bearing culms. There was no significant difference among the three varieties in the mean number of bearing culms. The means were 6.39 $\mp$ 0.165 for Nira, 6.49 $\mp$ 0.126 for Rexoro, and 6.81 $\mp$ 0.159 for Iola.

Number of nonbearing culms. Statistical comparison of the means of the number of nonbearing culms—0.91 $\mp$ 0.094 in Rexoro, 1.29 $\mp$ 0.168 in Nira, and 1.41 $\mp$ 0.169 in Iola—indicated that there was a significant difference between the highest mean (Iola) and the lowest (Rexoro) and between the second highest (Nira) and the lowest, but no significant difference between the highest and the second highest.

The results point to the superiority of Iola over the other two varieties in tillering capacity. In the production of total number of tillers the difference between Iola and Rexoro was highly significant, whereas in the number of nonbearing culms there was a significant difference between Nira and Rexoro, and between Iola and Rexoro.

Panicle and grain character

Length of panicle. Statistical comparison of the means of panicle length—27.35 $\mp$ 0.335 cm. in Rexoro, 30.77 $\mp$ 0.92 cm. in Nira, and 31.61 $\mp$ 0.314 in Iola—showed a highly significant difference between the highest mean (Iola) and the lowest (Rexoro) and between the second highest mean (Nira) and the lowest, but no significant difference between the highest mean and the second highest.

Awn character. The three varieties were all nonbearded.

Texture of grain. The texture of the grain of the three varieties was hard, showing that they were all of good milling quality.

[5] The number of bearing and nonbearing culms produced in a stool of rice.

Number of grains per panicle. There was a marked difference in the total number of grains produced, the difference being all highly significant, as the statistical comparison of the following means of the number of grains to a panicle shows: Iola, 184.40 ∓ 5.049; Nira, 226.7 ∓ 4.823; and Rexoro, 276.80 ∓ 4.829.

Number of filled and empty grains. The means of the number of filled and empty grains were 129.40 ∓ 4.116 and 51.70 ∓ 2.093 for Iola, 142.90 ∓ 4.646 and 82.90 ∓ 2.292 for Nira, and 217.0 ∓ 5.155 and 60.30 ∓ 2.319 for Rexoro. Statistical comparison of the means revealed the following: that there was a highly significant difference in the mean number of filled grains between the highest (Rexoro) and the lowest (Iola), and between the highest and the second highest, and a significant difference between the second highest and the lowest; and that there was a marked variation in the number of empty grains produced by each variety, as the differences among the means were all highly significant.

Relative proportion of the filled and empty grains. There was a marked difference in the percentage of filled and empty grains among the three varieties. Rexoro had the highest percentage of filled grains (78.39 per cent) but the lowest percentage of empty grains (21.78 per cent). Iola ranked second to Rexoro in percentage of filled grains, with 78.17 per cent, and second to Nira in empty grains (28.03 per cent). Nira had 63.03 per cent of filled grains and 36.56 per cent of empty grains. The fact that the strong winds during the flowering stage did not greatly affect Rexoro showed that this variety can withstand strong winds more than Iola or Nira.

Weight of grains. The means of the weight of grains varied from 3.32 ∓ 0.469 grams in Nira to 4.37 ∓ 0.115 grams in Rexoro. Iola had a mean weight of 3.59 ∓ 0.507 grams. Statistical comparison indicated a significant difference between the highest mean (Rexoro) and the lowest (Nira), but no significant diference between the highest and second highest (Iola) and between the second highest and the lowest.

Length of grains. The mean length of grains (figure 1) of 9.9 ∓ 0.087 mm. in Rexoro, 10.11 ∓ 0.089 mm. in Iola, and 10.42 ∓ 0.097 mm. in Nira, showed a decreasing statistical difference from a highly significant difference between the highest and the lowest, to a significant difference between the highest and the second highest, and to the difference between the highest mean and the lowest, which was not significant.

Width of grains. Iola and Nira appeared almost equal in width of grains, while Rexoro had highly significantly narrower grains than either of the two. The mean width of grains (figure 1) ranged from 2.86 ∓0.011 mm. in Rexoro to 3.25 ∓ 0.008 mm. in Iola. Nira had a mean width of 3.25 ∓ 0.011 mm.

In spite of the fact that Rexoro had a shorter panicle than the other two varieties, it produced the greatest number of grains which were the heaviest in the lot. On the other hand, Nira had the longest grains and the second greatest number of filled grains on the panicle but the greatest number of empty grains and the lightest grain weight. Although Iola had the least number of empty grains on each panicle, its yield of filled grains was heavier than that of Nira.

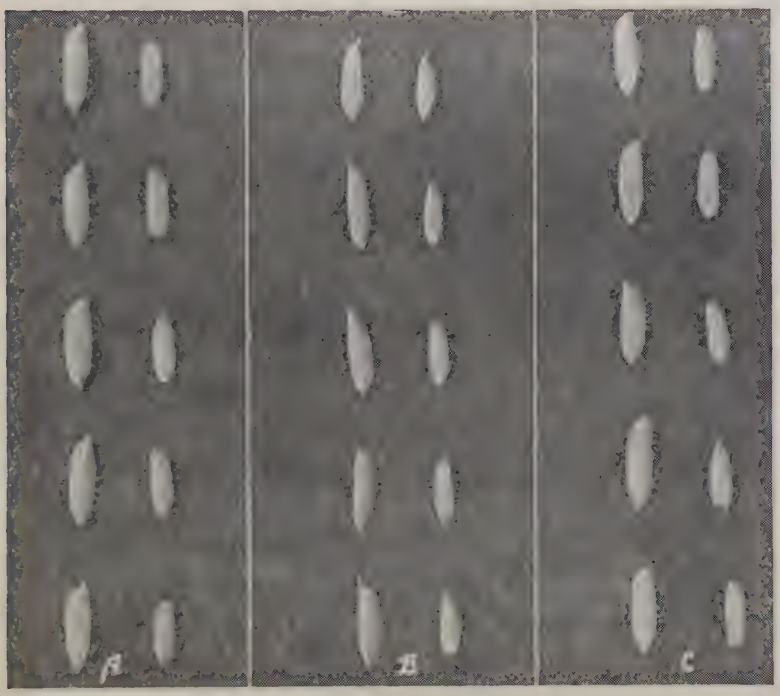


Fig. 1 — Grains and kernels of rice varieties *A*, Iola, *B*, Rexoro, and *C*, Nira. About natural size.

SUMMARY

1. The seeds of Rexoro, Nira, and Iola germinated five days after sowing. The seedlings were of uniform height and color. No pests and diseases were observed in the seedling stage.

2. The maturity periods of the plants grown in the College were much shorter than those obtained at various rice experiment stations in the United States.

3. The three varieties studied appeared to be resistant to diseases but were seriously affected by the red rice weaver, *Lonchura ferruginosa jagori* Martens.

4. The three varieties of rice exhibited slight variations in the color of the different plant organs.

5. In the United States, Nira was the tallest of the three varieties, followed by Iola and Rexoro. The same ranking was also observed when they were grown in the College of Agriculture at Los Baños.

6. While Rexoro was the latest to mature among the three varieties when grown at the three rice experiment stations in the United States, it matured the earliest under College conditions.

7. Rexoro had the shortest panicle but had the greatest number of grains on each panicle. The proportion of filled to empty grains was high (filled grains being 78.39 per cent and empty grains, 21.78). The grain of Nira was the longest, and its width was the same as Iola's. Rexoro had the narrowest grain. Nira, however, produced more empty grains to a panicle and also had the least weight of filled grains.

8. Rexoro had the heavest weight of grains-to-the-panicle, followed by Iola and Nira.

9. Ranked for commercial purposes, the order is Rexoro, Iola, and Nira.

A STUDY OF THE TRANSMISSION OF THE CORN MOSAIC AND OF SOME OF THE PHYSICAL PROPERTIES OF ITS VIRUS[1]

ORENCIO M. LAWAS AND WILLIAM L. FERNANDEZ
Of the Department of Plant Pathology

WITH THREE TEXT FIGURES

The corn mosaic, though a minor disease in the Philippines, is of some importance because it infects the sugar cane. In Jamaica, British West Indies, any district within one fourth of a mile (0.402 km.) of sugar-cane fields of five acres (2.02 ha.) or more in extent, is considered a cane priority district. Within the area covered by this radius no corn and sorghum may be grown within 100 yards (91.4 m.) of the sugar cane without permission from the government because of the danger of infection with mosaic from the corn or sorghum (Anon., 1942). In the United States the reverse is true; Ullstrup (1943) noted that the mosaic of dent corn occurs only in the vicinity of sugar-cane fields infected with the grass mosaic.

In regard to the economic importance of corn mosaic in America, Brandes (1920) reported that the decrease in size of the ears is appreciable in affected plants, and partial or complete sterility may result. According to Stoneberg (1927), the economic significance of corn mosaic lies in the fact that corn is a favored food plant of *Aphis maidis* Fitch, the vector of sugar-cane mosaic. When this aphid abandons corn in search of fresh food plants, the mosaic disease is readily transmitted back to the cane from which it has originally come.

The corn mosaic is caused by *Marmor sacchari* Holmes, the sugar-cane mosaic virus, also known as the grass-mosaic virus, sugar-cane virus 1, Saccharum virus 1, and corn-mosaic virus of Brandes (1920).

This study was conducted from December, 1946, to May, 1948, primarily for recording the occurrence of the disease in the Philippines and its methods of transmission.

SYMPTOMS

The first indication of the disease is in the form of dots or elongate to spindle-shaped pale areas appearing on the lower part of the leaf (fig. 1). The large spindle-shaped areas are not some-

[1] Experiment Station Contribution No. 1511, presented by the senior author as thesis for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, June, 1948. Prepared in the Department of Plant Pathology under the direction of Professor G. O. Ocfemia and the junior author.

times quite solidly chlorotic; a green portion, circular to elliptic in shape, may be present in the center. The spindle-shaped and elongate pale areas, whose long axis is parallel to the leaf veins, are arranged closely in rows on the leaf blade on one or both sides of the midribs. Soon the pale areas coalesce and the effect is a somewhat diffuse blotching of green tissue upon a paler green background (fig. 1).

Fig. 1 — The portions of three leaves of corn at the right were from a mosaicked plant. The fourth leaf, left, was from a healthy corn plant. *Photographed by G. Laforteza.*

The next leaves that emerge may show either a distinct or a rather vague mottling. In general, the young leaves are more chlorotic than the older ones because the leaves tend to recover the normal color as they mature. Often, towards the base of these leaves, especially before they recover the normal green color, there are produced broad lines of green and pale green alternating with one another.

There is a considerable reduction in the size of the infected plants. Those that are infected at a later stage of development pro-

duce ears (fig. 2) which are not so large and well-filled with kernels as those from healthy plants.

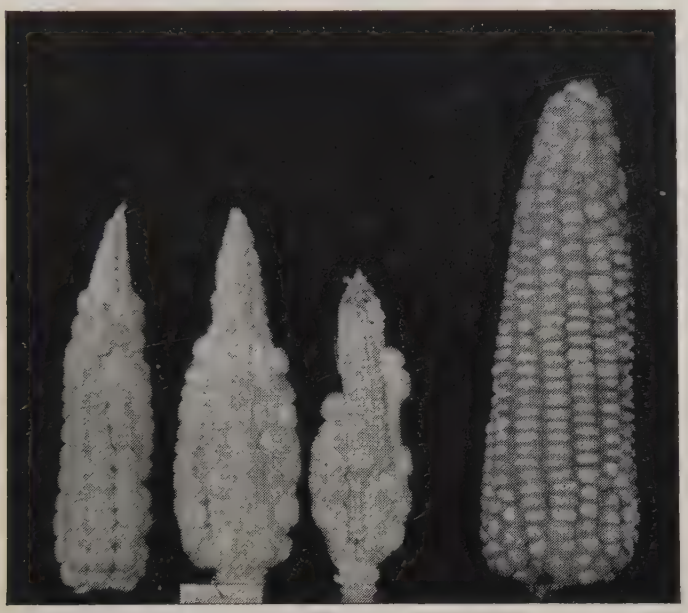


Fig. 2 — The three ears at the left were from mosaicked corn plants. Ears similar to these were used in the experiment on transmission of the disease through the seed. The ear at the right was taken from a healthy corn plant. *Photographed by G. Laforteza.*

METHODS OF TRANSMISSION

Transmission through seed

Kernels from ears of mosaicked corn plants were germinated in several tests, but none of the seedlings showed the symptoms of mosaic. The results corroborated the reports of workers on corn mosaic that the disease is not transmitted through the seed.

Transmission by mechanical methods

With crushed tissues. Crushed fresh leaves of corn infected with corn mosaic and rubbed against the lower and upper surfaces of the leaves of healthy corn plants did not transmit the disease.

When healthy corn plants were abrased with carborundum and then rubbed with the fresh crushed tissues, a number of the inoculated plants became diseased in 8 to 28 days.

The results of transmission by mechanical means indicated that corn mosaic virus could be transmitted with an abrasive to some of the experimental plants with crushed tissues. Bain (1944), in his inoculation of sugar-cane seedlings with mosaic, obtained three times more infection when he used an abrasive than Matz' method of virus inoculation. Kalmus and Kassanis (1945) explained "that the trichomes, as well as the cuticle layer, are removed by rubbing, but they may require greater initial virus attack than the epidermal leaf cells, in which case the effect of abrasives may lie in exposing these more susceptible cells which are usually resistant to rubbing."

By pin pricks. Two to three leaves of each corn plant were inserted into the fold of a fresh leaf of a diseased plant. The diseased leaf was pricked rapidly many times through the other side. After a period of incubation of 4 to 31 days, about 16.6 to 90 per cent infection occurred. Holmes (1939) states that the corn mosaic can be transmitted by pin pricks.

Sap transmission. Pieces of sterile cotton soaked in fresh expressed juice of mosaicked corn were placed around the bases of young leaves of maize plants and then pricked with a pin through the cotton to the midrib. About 62 to 85 per cent of the treated plants were diseased in 5 to 17 days.

Transmission by insects

Description of method. The aphids to be tested were allowed to feed on corn with mosaic for one or two hours, and then 10 to 15 individuals were transferred with a camel's hair brush to each of the experimental plants.

The leafhoppers *Peregrinus maidis* Ashm. and *Proutista moesta* Westwood were allowed to feed on the mosaicked corn plant for 24 to 48 hours. Five to ten individuals were transferred with an insect aspirator to each plant.

The insects for the control plants of each experiment were left to feed on healthy plants.

Transmission with Aphis maidis Fitch and A. gossypii Glover. *Aphis maidis* Fitch and A. *gossypii* Glover transmitted the corn-mosaic virus to healthy corn plants. The smallest number of *Aphis gossypii* necessary to transmit the disease was three individual aphids, and the incubation period required was 12 to 23 days.

The sugar-cane or grass mosaic is transmitted by four species of aphids — *Aphis maidis* Fitch, *Carolinaia cyperi* Ainslie, *Hysteroneura setariae* (Thomas), and *Toxoptera graminum* Rond (Holmes, 1939). In this work the writers transmitted corn mosaic to corn with *Aphis gossypii.* This seems to be the first record of *Aphis gossypii* as vector of corn mosaic. Although the writers expected

that *Aphis maidis* Fitch, the vector of sugar-cane mosaic, could cause more successful transmission of the disease than *Aphis gossypii* they noted that the former was a less efficient vector. The junior author found that *Aphis maidis* can transmit *Canna indica* mosaic to abacá (*Musa textilis* Neé), and the abacá mosaic (*Marmor cucumeris* Holmes) to corn. Furthermore, *A. maidis* can recover the abacá-mosaic virus from the infected corn and transmit it back to abacá and to another corn plant. However, although *Aphis gossypii* is one of the vectors of abacá mosaic, it cannot transmit abacá mosaic to ornamental Canna varieties and *Canna edulis;* it can transmit *Canna indica* mosaic to abacá, *Canna edulis,* and ornamental *Canna* varieties.

Transmission with Peregrinus maidis Ashm. and Proutista moesta Westwood. Repeated trials failed to transmit the mosaic disease from corn to corn with *Peregrinus maidis* Ashm. and *Proutista moesta* Westwood.

Kunkel (1921) recorded transmission of sugar-cane mosaic and corn mosaic by the corn leafhopper, *Peregrinus maidis.* He believed it was strange that *P. maidis* could transmit the mosaic disease from corn to corn but not from corn to sugar cane. Kunkel noted that one of the viruses harbored by the corn is the cause of the destructive maize mosaic in Hawaii and the other, the cause of the sugar-cane or grass mosaic. Stahl (1927) described the stripe disease of corn in Cuba and stated that the disease was not identical with the sugar-cane mosaic. The writers' corn mosaic is identified with the sugar-cane or grass mosaic which infects many members of the family Gramineae and, in controlled inoculations, may be induced to infect plants of other families.

SOME PHYSICAL PROPERTIES OF THE VIRUS

Thermal inactivation point

Fresh mosaicked corn-juice extract that had been heated to and maintained at each of the following temperatures: 40°, 45°, 55°, 48°, 50°, 52°, 54°, and 56° C. for 10 minutes showed that the virus was inactivated at 54°, 55°, and 56° C. These temperatures are close to the thermal inactivation points for sugar-cane mosaic virus of 53° to 54° C. recorded by Smith (1937) and Holmes (1939).

Dilution end point

Infections were produced on corn plants inoculated with the undiluted extract and with that diluted 1:10. Beyond this dilution the extract was no longer infective in repeated inoculations. Rafay's (1935) work on the virus of sugar-cane mosaic gave the same result.

Resistance to aging

Matz (1933) reported that the virus extract of sugar-cane mosaic stored for 28 days at 4° C. produced 21 per cent of infection. When the extract was frozen within 20 minutes after its preparation and subsequently stored for about 27 days at -6° C., Matz (1933) obtained 45 per cent of transmission. Rafay (1935) reported that the sugar-cane mosaic virus lost its virulence after four hours of storage at 20° C. In the writers' work, corn plants inoculated with the juice stored for 12 hours with toluene as preservative were infected. At the high room temperatures (26° to 28° C.) in the Philippines, the virus was inactivated *in vitro* after 24 hours.

HOST RANGE

In this study, the writers found in reciprocal experimental transmission tests that the corn mosaic readily infected *Eragrostis amabilis* (Linn.) W. and A., kulape (*Paspalum conjugatum* Berg.), *Digitaria corymbosa* (Roxb.) Merr., *Eleusine indica* (Linn.) Gaertn., *Dactyloctenium aegyptium* (Linn.) Willd., *Andropogon sorghum* (Linn.) Brot. (fig. 3), and *Andropogon halepensis* (Linn.) Brot.

Fig. 3 — The portions of three leaves of sorghum at the left show characteristic mottling caused by the corn mosaic. The fourth leaf, right, was from the healthy sorghum plant used as check in the experiment. *Photographed by G. Lafortezа.*

The symptoms on grasses and sorghum appeared after an incubation period of 10 to 27 days. The symptoms were very similar to

those of the mosaic of corn. With *Aphis gossypii* the writers' corn mosaic also infected abacá (*Musa textilis* Neé) on which it produced a pattern different from that produced on abacá by the abacá-mosaic virus.

Brandes and Klaphaak (1923) transmitted sugar-cane or grass mosaic to 13 different species of grass, including sugar cane, corn, *Paspalum boscianum, Eleusine indica,* and sorghum.

The mosaic diseases of citronella (*Cymbopogon nardus* Rendle), *Paspalum conjugatum,* and of aguiñgay (*Rottboellia exaltata* Linn.) probably due to the same virus, *Marmor sacchari,* were also transmitted to corn on which the symptoms produced were very similar to those caused by the writers' corn mosaic.

SUMMARY

1. The writers' corn mosaic caused by *Marmor sacchari* Holmes, although a minor nuisance, is of importance because it causes the mosaic of sugar cane, which is a major disease of this crop.

2. The disease was transmitted for the first time with *Aphis gossypii* Glover of which three individuals were sufficient to effect transmission. Like the sugar-cane or grass mosaic, the writers' corn mosaic was transmitted with crushed tissues through abrasion on the leaves and through pin-pricks on the midribs at the bases of the young leaves. The virus was inactivated in 10 minutes at 45° C. and in 24 hours at room temperature. It tolerated dilution of 1:10.

3. In reciprocal transmission experiments, the corn disease was transmitted to *Eragrotis amabilis* (Linn.) W. and A., *Eleusine indica* (Linn.) Gaertn., *Cymbopogon nardus* Rendle, *Paspalum conjugatum* Berg., *Andropogon sorghum* (Linn.) Brot., *Andropogon halepensis* (Linn.) Brot. *Digitaria corymbosa* (Roxb.) Merr., *Dactyloctenium aegyptium* (Linn.) Willd., and *Musa textilis* Neé. The abacá mosaic caused by *Marmor cucumeris* Holmes was transmitted with *Aphis maidis* to corn and abacá. From the infected corn and abacá, this aphid drew the virus and transmitted it to other corn and abacá plants. The mosaic of citronella (*Cymbopogon nardus* Rendle), mosaic of kulape (*Paspalum conjugatum* Berg.), and mosaic of aguiñgay (*Rottboellia exaltata* Linn.), probably caused by the same *Marmor sacchari,* were transmitted mechanically to corn on which each produced symptoms very similar to corn mosaic.

4. The corn mosaic in the Philippines is identified with the sugar-cane or grass mosaic.

LITERATURE CITED

ANON. 1942. Cane mosaic disease legislation. Jour. Jamaica Agric. Soc. 46: 210. *Cited in* Rev. Appl. Mycol. 22: 352. 1943.

BAIN, D. C. 1944. The use of abrasives for inoculating sugar cane seedlings with the mosaic virus. Phytopath. 34: 844-845.

BRANDES, E. W. 1920. Mosaic disease of corn. Jour. Agric. Res. 91: 517-522. *Pl. 95-96.*

BRANDES, E. W. AND P. J. KLAPHAAK. 1923. Cultivated and wild hosts of sugar-cane or grass mosaic. Jour. Agric. Res. 24: 247-262. *Pl. 1-4.*

HOLMES, F. O. 1939. Handbook of phytopathogenic viruses. vii + 221 p., Minneapolis, Minn. Burgess Publishing Company.

KALMUS, H., AND B. KASSANIS. 1945. The use of abrasives in the transmission of plant viruses. Ann. Appl. Biol. 32: 230-235. *Cited in* Rev. Appl. Mycol. 25: 95-96.

KUNKEL, L. O. 1921. A possible causative agent for the mosaic disease of corn. Bull. Exp. Sta. Hawaiian Sugar Planters' Assoc., Bot. Ser., 3 (1): 44-58. *Pl. 1-12, fig. 1-2.*

MATZ, J. 1923. Artificial transmission of sugar cane mosaic. Jour. Agric. Res. 46: 821-839. *Fig. 1.*

RAFAY, S. A. 1935. Physical properties of sugar cane mosaic virus. Indian Jour. Agric. Sci. 5: 663-670. *Fig. 1.*

STAHL, C. F. 1927. Corn stripe disease of Cuba not identical with sugar cane mosaic. Trop. Plant Res. Found. Bull. 7: 3-11.

STONEBERG, H. F. 1927. The productiveness of corn as influenced by the mosaic disease. U. S. Dept. Agric. Tech. Bull. 10: 1-18.

ULLSTRUP, A. J. 1943. Diseases of dent corn in the United States. U. S. Dept. Agric. Cir. 674: 1-34. *Fig. 1-22.*

STUDIES ON THE SOLVENT EXTRACTION OF COCONUT OIL WITH ETHYL ALCOHOL[1]

APOLINARIO R. CARAÑGAL, JR. AND JULIAN BANZON
Of the Department of Agricultural Chemistry

WITH ONE TEXT FIGURE

The oil from copra is usually extracted by pressure with either hydraulic presses or expellers. One of the recent developments in oil technology used extensively in Germany in soybean-oil extraction is the use of solvent for extracting. The most common of these solvents are light petroleum fractions recovered from natural gas.

Earlier experiments in the Department of Agricultural Chemistry of this College indicated the possibility of using ethyl alcohol as a solvent because of the following favorable circumstances: first, coconut oil is soluble in 95 per cent ethyl alcohol at boiling temperature; second, the oil is thrown out of solution when the temperature is lowered; and third, the difference in specific gravity between coconut oil and alcohol is sufficient enough to expect a clear-cut separation upon cooling. This separation, however, was not easily accomplished, and the problem of breaking the oil from the alcohol presented itself. This study, conducted in the Department of Agricultural Chemistry from October, 1946, to October, 1947, was undertaken in an effort to facilitate the problem of separating the oil from coconut through the solvent extraction of ethyl alcohol.

While this investigation was in progress, it was announced that in the United States a continuous extraction of soybean oil using alcohol as solvent had proved successful in a pilot plant scale.[2] Measmer (1942) reported the extraction of oil from soybean with a mixture of trichloroethylene and ethyl alcohol as solvent.[3] Literatures on solvent extraction, its application, principles, solvents used, and advantages are described by Bailey.[4]

The coconut shreds for this study were prepared from sun-dried grated nuts resembling desiccated coconut without the brown part of the meat that would discolor the samples. The copra samples were made from mature nuts which were shaved off thinly with a carpenter's plane and then dried in the sun. The brown portion of the nut was retained to simulate locally made copra.

[1] Experiment Station Contribution No. 1512. Based on the thesis presented by the senior author for graduation with the degree of Bachelor of Science in Agriculture, October, 1947. Prepared in the Department of Agricultural Chemistry under the direction of the junior author.

[2] Chemical Newsletter 1: 4.

[3] Chemical Abstracts 37: 3288.

[4] Bailey, A. 1945. Industrial oil and fat products. xii + 725 p. Baltimore, Md.: Waverly Press.

The solvents used were 95 per cent ethyl alcohol, acetone, ether, chloroform, and dehydrated alcohol (prepared by mixing 30 grams of calcium oxide with each liter of 95 per cent ethyl alcohol and allowing the mixture to stand overnight).

A heater, a water bath, Erlenmeyer flasks (125, 250, and 500 ml.), and a reflux condenser comprised the extraction system. The recovery system was ice water (12°—18° C.) contained in a beaker.

The analytical apparatus consisted of a Soxhlet extractor setup, calibrated test tubes, and other common laboratory appliances.

The oil content of the sample and the percentage purity of the ethyl alcohol were determined according to the fourth edition of the official and tentative methods of analysis of the Association of Official Agricultural Chemists in 1935.

EXPERIMENTS AND RESULTS

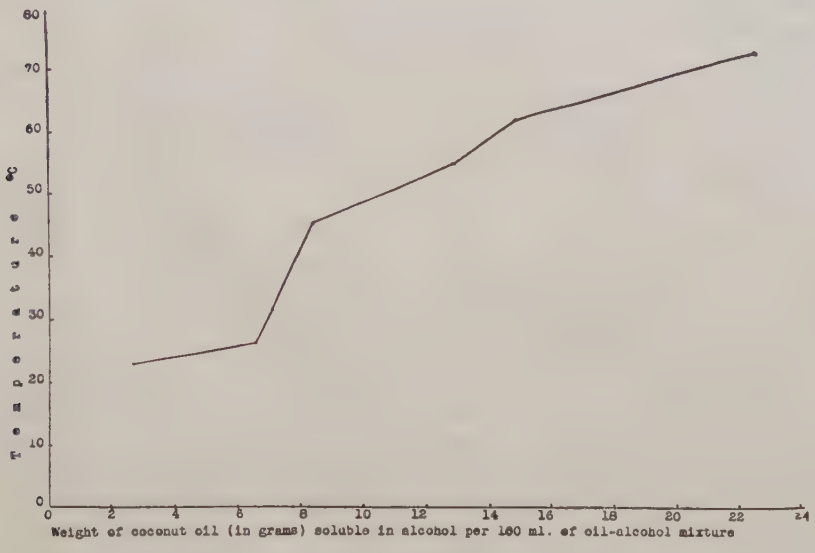
One of the objects of all extraction processes is to obtain as high a yield as is consistent with the economy of the process. In the solvent extraction of coconut oil, the effects of temperature, the volume of the solvent, the addition of organic solvents (such as acetone, ether, and chloroform), and the nature of the samples were studied to find the best conditions for obtaining a high percentage of extraction. Since the solvent recovery constitutes a substantial part of the operating costs, the length of the separation of the oil from the "miscella," the retention of the "miscella" in the extracted meal, and the solvent losses were studied. Measurements were made to determine the percentage of extraction and the time involved in oil separation.

Preliminary experiment

Solubility of coconut oil in 95 per cent ethyl alcohol. In order to verify the results of earlier studies in the Department of Agricultural Chemistry laboratory of this College on the solubility of coconut oil in alcohol, two phases of coconut oil and 95 per cent ethanol were stirred in Erlenmeyer flasks at temperatures ranging from 23° to 73° C. The oil-in-alcohol solution formed a layer on top of the alcohol-in-oil solution. This lower oil layer was allowed to settle completely before pipetting off 20 ml. of the upper layer of oil-in-alcohol solution. The alcohol was then evaporated from the 20 ml. portion until the residual oil attained a constant weight. The result shown in chart 1 corroborated earlier results that the solubility of coconut oil in 95 per cent ethyl alcohol increases as the temperature rises from the freezing point of the oil (23° C.) to the boiling point of the mixture (73° C.).

Ethyl alcohol extraction of oil from coconut "shreds"

Method of extraction. Based on previous experiments, the extraction of the oil from the samples was done at 73° C. and the principle of solvent re-use applied. Ten-gram samples, together with the solvent, were heated over a water bath in an Erlenmeyer flask that served as the extraction chamber. A reflux condenser was used to prevent losses due to vaporization. After being heated for a certain length of time, the "miscella" (the oil-in-alcohol solution), while its temperature was still 73° C., was poured into calibrated test tubes.



As the "miscella" cooled off, the dissolved oil separated; but instead of forming a definite layer as anticipated from the difference in specific gravity between the oil and the alcohol, the oil remained in the form of minute droplets distributed in the alcohol. To facilitate the separation of the oil from the alcohol, the temperature was lowered so that the oil would solidify The test tubes containing the "miscella" were immersed in water at 12°-18° C. The solvent was poured off and used for the next extraction. The loss in solvent in the previous extraction was made up by the addition of alcohol. The same procedure was followed until practically all the oil from the same was extracted. As coconut oil has a higher freezing point than most vegetable oils, the "freezing operation" requires only a few degrees below room temperature.

Effects of solvent-oil ratio and extraction time. Bailey (1945) found that complete extraction can only be accomplished with the

use of a solvent larger in volume than the oil to be extracted. In the Bollman or Hansa-Muhle extractor an extraction time of one hour for each basket is required to effect a high yield of oil.

Different solvent-oil ratios and extraction times were studied. Solvent-oil ratios of 4:1, 6:1, 8:1, and 10:1 and extraction times of 2½, 5, 7½, 10, 12½, and 15 minutes were considered. The above solvent-oil ratios were tried with each of the extraction time. Losses in the volume of the solvent due largely to retention of the samples were made up by the addition of fresh solvents. The percentage of extraction was calculated from the volume and was based on the Soxhlet determination which takes into consideration the amount of solvent retained by the oil.

The results given in table 1 show that at constant extraction time, the average percentage of extraction of three replications increased as the solvent-oil ratio was increased from 4:1 to 10:1. The average percentage of extraction decreased from the first to the last extraction.

Regarding the effect of extraction time (table 1), the total percentage of extraction at constant solvent-oil ratio before equilibrium condition was reached, was in direct proportion to the extraction time. Equilibrium was attained with a 10:1 solvent-oil ratio when the extraction time was 7½ minutes.

Effects of the addition of organic solvents. Ether, acetone, and chloroform were the other organic solvents used in this experiment to increase the solubility of coconut oil in alcohol. Acetone and ethyl ether have been reported as having been used to some extent in oil extractions from wet materials like fish-liver oils. This study was undertaken to determine the performance of these solvents and their effect on the percentage of extraction.

The boiling points of these solvent-alcohol mixtures were determined because the boiling point of the solvent puts an upper limit to the highest extraction temperature. The mixtures tried were 1/5, 1/3, 1/2, and 2/3 parts of the organic solvent by volume of total solvent, the remaining part being alcohol. As shown in table 2, the results showed that the addition of ether, acetone, and chloroform lowered the boiling point of the mixture.

The extraction was done the usual way with three replications. Ten-gram samples were subjected to extraction for 5 minutes with a 4:1 solvent-oil ratio because under this condition the percentage of extraction was low (74.70 per cent). The control alcohol extractions were run for each mixture for comparison.

The addition of ether and acetone increased the total percentage of extraction from 10 to 46.50 per cent, as shown in table 2. The addition of ether caused a larger increase in extraction than that of acetone in all mixtures and at much lower temperature.

In regard to their efficiency in oil separation, the oil of the miscella from the samples where the solvents used were alcohol and chloroform and 2/3 part ether (1/3 alcohol) did not separate from the solvent; hence, no determinations of the percentage extraction were possible. With 2/3 part acetone (1/3 alcohol) as solvent, the oil separated; but unlike the previous extractions where alcohol alone was used, a slight rise in temperature caused miscibility of the solidified oil with the solvent, thus causing difficulty in separation.

Extraction of oil from copra

This experiment was performed because coconut oil is usually extracted from copra. The samples were subjected to extraction for 15 minutes with 20 ml. of solvent. The results of three replications showed that, on the basis of equal oil content, the percentage of extraction under the same conditions was much lower compared with that of coconut shreds. Copra gave 62.05 per cent and coconut shreds 90.82 per cent. This lower percentage of extraction from copra may be due to the larger size of the flakes although they were very thin.

Extraction of coconut oil with dehydrated alcohol

Because of the inflammability of alcohol, the use of dehydrated alcohol as solvent without heat was studied. A 10-gram sample of shreds and 30 ml. of dehydrated alcohol were placed together in an Erlenmeyer flash. The extraction time was 15 minutes at room temperature (34° C.), and the principle of solvent re-use was applied. The sample and the solvent were stirred once in a while. The results showed 41 per cent extraction as against 89.6 per cent when boiling 95 per cent ethyl alcohol was used.

Solvent recovery

Retention of "miscella" by the residue. This experiment was based on the assumption that there was no loss of solvent from vaporization. In previous experiments on the effects of solvent-oil ratio and extraction time, the volumes of the oil extracted and the miscella were measured. With these data, the amount of solvent retained by the meal after extraction was determined. The results indicated that, on the average, 10.5 ml. were retained by a 10-gram sample (table 3). This amount of solvent retained could be reduced by centrifuging, pressing, or vaporizing. This aspect of the problem was not considered in this study.

Length of time of separation of the oil from the "miscella"

In these experiments the effects of the volume of the oil and "miscellla" on the separation time were studied. The "miscella" was prepared as in the determination of solubility of oil in ethyl

alcohol. By varying the temperature, the volume of oil miscible in the solvent could be varied, leaving the volume of the "miscella" constant. The behavior and characteristics of the "miscella" until the oil separates are shown in table 4. The criterion used in the determination of the time of separation was the appearance of a clear solvent on the upper portion of the "miscella" after the oil of that portion had solidified. At this time the oil suspended in the solvent was allowed to settle by rotating the tube.

The results, as given in table 5, show that the volume of the oil in the miscella had nothing to do with the length of separation time. However, the volume of the "miscella" was found to be directly proportional to the separation time (table 6).

Ethyl alcohol extraction of coconut oil from 100 grams of coconut shreds

On the whole, the experiments on the extraction of oil from 10-gram samples gave satisfactory results. To show that this method of extraction could be used on a larger scale, experiments using 100-gram samples were performed, using a 4:1 solvent-oil ratio and extraction time of 15 minutes. The volume of the oil extracted, the solvent recovered, and the miscella were measured, and the losses of the solvent were determined by evaporation from the oil and extracted meal.

A balance sheet for three replications gave the following average results:

Sample:	Coconut shreds		
	Original weight	100	grams
	Oil content (based on Soxhlet)	46.216	grams
	Oil extracted	43.14	grams
	Percentage of extraction	93.4	per cent
Solvent:			
	Volume of solvent	200	ml.
	Solvent recovered	91	ml.
	Solvent retained by the shreds	90.1	ml.
	Solvent retained by oil	6.9	ml.
	Losses (per 46.216 grams of oil)	12	ml.
Residues:			
	Weight of the extracted meal (dry)	53.07	grams
	Percentage of oil in meal	5.8	per cent
	Unaccounted for	3.79	grams

With 10-gram samples, the percentage of extraction was 90.8 per cent as against 93.4 with 100 grams; the solvent retained was 90.1 ml. for the 100 gram-sample.

SUMMARY

1. The solvent extraction of oil from coconut shreds with 95 per cent ethyl alcohol, ether and 95 per cent ethyl alcohol, and acetone and 95 per cent ethyl alcohol was carried out at boiling temperatures.

2. The solubility of coconut oil in 95 per cent ethyl alcohol was in direct proportion to the temperature from 23° to 73° C.

3. In the alcohol extraction of coconut oil, the following conditions increased the percentage of extractions:

(a) increasing the solvent-oil ratio from 4:1 to 10:1 at constant extraction time;

(b) increasing the extraction time from 2½ to 15 minutes at constant solvent-oil ratio before the equilibrium condition is attained;

(c) adding ether and acetone up to 50:50 parts by volume of the 4:1 solvent-oil ratio.

4. The use of dehydrated alcohol did not give a high yield of oil at 34° C. extraction temperature.

5. Copra shavings were less suitable for solvent extraction than coconut "shreds."

6. In separating the oil from the "miscella" by solidifying it, the separation time was directly proportional to the volume of the miscella. The volume of the oil in the "miscella" did not affect the separation time.

7. The solvent extraction of coconut oil with 95 per cent ethyl alcohol is feasible on a laboratory scale; the percentage of extraction is 93.4.

TABLE 1

Average percentage of extraction of coconut oil from the shreds, using different solvent oil ratios and extraction times[a]

SOLVENT OIL RATIO	EXTRACTION	2-½ MINUTES	5 MINUTES	7-½ MINUTES	10 MINUTES	12-½ MINUTES	15 MINUTES
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
	1st	28.7	28.7	34.0	35.2	38.7	38.7
	2nd	19.3	21.1	21.1	21.1	21.1	24.6
4:1	3rd	9.9	10.5	10.5	9.9	9.9	11.7
(20 ml.)	4th	6.5	6.2	6.7	5.9	6.5	8.2
	5th	3.5	4.7	3.5	4.0	3.5	3.6
	6th	3.5	2.3	2.3	2.9	2.4	2.3
	7th	1.2	1.2	1.2	1.7	1.2	1.8
	Total	72.6	74.7	79.3	80.7	83.3	90.9
6:1 (30 ml.)	5	75.0	79.1	82.6	84.4	84.4	89.6
8:1 (40 ml.)	5	78.5	79.7	90.2	92.6	91.9	95.5
10:1 (50 ml.)	4	79.7	94.5	96.7	97.3	96.7	96.7

[a] The percentage of extraction was based on Soxhlet determination which takes into consideration the specific gravity of the oil (0.9163) and the amount of solvent retained by the oil (0.1134 gm/gm oil).

TABLE 2

Extraction temperature (T) and average percentage of extraction of coconut oil upon the addition of other organic solvents[a]

FRACTION OF ORGANIC SOLVENT	ETHYL ALCOHOL ALONE		ETHYL ALCOHOL AND ACETONE		ETHYL ALCOHOL AND ETHER	
	T	Extraction	T	Extraction	T	Extraction
	°C.	*per cent*	°C.	*per cent*	°C.	*per cent*
One fifth	68	73.5	68	84.2	55	90.4
			Increase	10.7		16.9
One third	66	63.9	66	87.8	53	96.9
			Increase	23.9		33.0
One half	63	45.1	63	84.5	49	91.6
			Increase	39.4		46.5

[a] The computation of the percentage of extraction of oil was based on Soxhlet determination which takes into account the specific gravity of the oil and the amount of solvent retained by the oil.

TABLE 3

Solvent retention by the extracted meal

SOLVENT OIL RATIO	SOLVENT RETAINED BY THE EXTRACTED MEAL AND OIL							X[a]	Y[b]
	2-½	5	7-½	10	12-½	15	Average		
	ml.	ml.	ml.	ml.	ml.	ml.	ml.	ml.	ml.
4:1 (20 ml.)	9.8	10.8	11.3	13.5	13.6	15.8	12.5	0.6	11.9
6:1 (30 ml.)	7.8	9.4	11.0	11.1	9.8	11.3	10.1	0.6	9.5
8:1 (40 ml.)	8.2	7.2	10.7	11.2	13.1	13.2	10.6	0.6	10.0
10:1 (50 ml.)	8.4	10.1	14.0	10.2	10.7	13.8	11.2	0.7	10.5

General average..... 10.5 ml.

[a] Solvent retained by the oil.
[b] Solvent retained by the extracted meal.

TABLE 4

Behavior and characteristic of the "miscella" during solidification

TIME	BEHAVIOR AND CHARACTERISTIC OF THE "MISCELLA"
1. Just after extraction	1. Either clear or turbid, depending on the oil content. Usually first and second extractions are turbid and "miscella" from next extractions are clear (73° C.).
2. Allowed to cool in air	2. Turbid; first and second extractions — the oil is seen at the bottom (58° C).
3. Placed in ice water	3. Turbidity increases as temperature goes down.
4. Five minutes later	4. Oil at the bottom solidifies; "miscella" still turbid (23° C).
5. Eight minutes later	5. Oil at the sides solidifies; "miscella" still turbid (below 23° C).
6. Next succeeding minutes	6. Oil dissolved in solvent solidifies beginning from the bottom to the top, resulting in floating white solidified oil.
7. When ready for separation by rotation	7. Oil suspended in the oil-solvent from top to the bottom.
8. During rotation	8. Suspended oil settles down; solvent clear.
9. During pouring	9. Solid oil at bottom; clear solvent is poured off.

TABLE 5

Effect of the volume of oil on the separation of oil by solidifying

1ST TRIAL		2ND TRIAL		3RD TRIAL	
Volume of oil	Time	Volume of oil	Time	Volume of oil	Time
ml.	*min.*	*ml.*	*min.*	*ml.*	*min.*
1.50	12	.30	40	.40	17
1.50	18	.40	42	.40	17
1.10	22	.60	43	.30	19
.60	11	.70	45	.20	19
.50	12	.60	55	.30	21
.30	14	.20	48	.30	22
.20	21	.70	55	.30	27
.20	16	.30	27	.30	22
.10	13	1.30	56	.30	27
.20	9	.50	37		
.10	18	.60	60		

[a] The time was measured from the moment the "miscella" was immersed in water till it was ready for separation. This is indicated by the clearness of the solvent on top.

TABLE 6

Effect of the volume of "miscella" on the separation of oil by solidifying[a]

VOLUME OF "MISCELLA"	1ST TRIAL		2ND TRIAL		3RD TRIAL	
	Time	Volume of oil	Time	Volume of oil	Time	Volume of oil
ml.	*min.*	*ml.*	*ml.*	*min.*	*ml.*	*min.*
5	8	.20	8	.20	9	.35
10	10	.20	11	.20	13	.50
15	14	.35	12	.40	14	.70
20	16	.30	19	.80	14	.90
25	19	.20	19	1.00	18	1.30
30	19	.50	19	1.40	22	1.60

[a] The time was measured from the moment the "miscella" was immersed in water till it was ready for separation. This is indicated by the clearness of the solvent on top.

THE PERFORMANCE OF THREE FEDERATED MALAY STATES RICE COMPARED WITH RAMINAD[1]

PELAGIO S. FAJARDO
Of the Department of Agricultural Education

In 1939 Aragon and Cada [2] noted that of the ten varieties of rice introduced into the Philippines from the Federated Malay States, Seraup Kechil 146, Seraup Kechil 36, Seraup Besar 15 (Sakapol), and Radin 2 were promising under local conditions. Two years later Calma and Cada [3] showed that Elon-elon A-5-36, Seraup Kechil 36, Seraup Kechil 146, and Elon-ram strain 8 were significantly higher yielders than Elon-ram strain 3 and Elon-ram strain 6.

Of the four promising Federated Malay States varieties of rice, three were compared in performance with Raminad in a work conducted from July 15, 1943, to February, 22, 1944, in the lowland rice fields of the Department of Agronomy of the College of Agriculture at Los Baños, Laguna.

EXPERIMENT, RESULTS AND DISCUSSION

A paddy of about 500 square meters where water is always available during the rainy season was divided into four plots, 5.5 meters wide and 20 meters long, for seedbeds. A space of about one meter wide was left between the plots.

The seeds of Seraup Kechil 146, Seraup Kechil 36, Seraup Besar 15, and Raminad were placed in gunny sacks, one for each variety, soaked in running water for 24 hours, and then placed in a shaded place for another 24 hours to sprout. On July 15, 1943, the soaked seeds of each variety were broadcast in beds prepared by the ordinary wet-bed method, at the rate of 25 gantas for every 500 square meters. The dikes of the paddy were left open to allow the excess to flow out. After the seeds had been sown, the dikes were closed so that the seeds would not be carried away or mixed.

The soil of the lowland rice field of the College Experiment Station where the seedlings were to be transplanted is clay loam. For some time the field had not been planted to any crop but rice.

---

[1] Experiment Station Contribution No. 1513. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1944. Prepared in the Department of Agronomy under the direction of Dr. V. C. Calma.

[2] Aragon, V. B., and E. Cada. 1939. A preliminary report on the performance of the rice varieties from the Federated Malay States. Philippine Agriculturist **27**: 635-646, *Fig. 1-4.*

[3] Calma, V. C., and E. Cada. 1941. A comparative test of six varieties of rice. Philippine Agriculturist **30**: 548-554.

It was followed after the rice harvest from January to July, and prepared again for the next rice crop.

The land, about 6,000 square meters, was prepared in the ordinary way of preparing a paddy. The field was divided into twenty plots of 300 square meters each, and each variety was replicated five times in plots arranged at random to give a basis for the analysis of variance.

On September 14, 1961, when the seedlings were 51 days old, they were pulled up from the seedbed, tied into bundles of uniform size, the roots washed and the tops pruned. Two to three seedlings were transplanted to hills about 25 centimeters apart.

A week after transplanting, water was turned into each plot and maintained to a depth of about five centimeters. Although the plots depended only on rain for water, the plants did not suffer from want of it. The paddies were drained whenever it was necessary. The plots were weeded once and after weeding water was turned into the paddies.

The crops were harvested on January 22, 1962, with a serrated knife "ani-ani". Because of inclement weather, the variety that matured a little later was not harvested on time. A harvester was assigned to each plot. The cut plants were threshed and winnowed, and the grains placed in a sack and weighed on a Fairbanks balance.

The four varieties exhibited a wide range of heights. The rice plants among the varieties varied significantly in height. Seraup Besar 15 was the tallest with a mean height of 134.26 ± 1.45 cm., followed by Rambad and Seraup Kechil 146 with mean heights of 131.01 ± 1.31 cm. and 130.64 ± 1.24 cm., respectively. Seraup Kechil 36 had the shortest plants with a mean height of 123.33 ± 2.27 cm., and it was the least affected by the typhoon. Rambad had the most uniform height, followed by Seraup Besar 15 and then by Seraup Kechil 146. Seraup Kechil 36 showed the greatest variability in the height of plants.

The four varieties produced more or less the same number of tillers. They did not vary significantly in the number of tillers with bearing culms. Rambad gave 13.3 ± 0.5; Seraup Besar 15, 12.8 ± 0.4; Seraup Kechil 146, 12.7 ± 0.5; and Seraup Kechil 36, 13.9 ± 0.5 bearing culms.

There was not much difference among the four varieties in number of days to mature. It took Rambad 191 days from sowing in the seedbed to harvest; Seraup Besar 15, 193 days; Seraup Kechil 146, 192 days; and Seraup Kechil 36, 192 days. The last three varieties matured 6 days later than that reported by Cuevas and

Cada (1941) and 16 days later than that found by Aragon and Cada (1939). The three varieties matured rather late probably because they remained in the seedbed for sometime.

All the four varieties lodged when they were nearing maturity, and only Seraup Kechil 36 was fairly resistant to strong winds.

After the typhoon on November 15, 16, 17, and 18, 1943, a sporadic attack of the rice leaf roller (*Cnapholocrosis medinalis* Guenée) was observed in the paddies of Raminad and Seraup Besar 15. Empty grains were occasionally found in some panicles of all four varieties due to the rice bug (*Leptocorisa acuta* Thunberg). As usual, "mayas" (*Lonchura ferruginosa jagori* Martens) attacked the cultures, but the birds were driven away with the use of scarecrows. No serious disease attacked the plants.

The total number of grains on the panicle of each variety varied significantly. Seraup Kechil 146 had the highest mean number of 98.2 $\mp$ 3.1 grains. Raminad, Seraup Besar 15, and Seraup Kechil 36 had similar statistical means of 86.5 $\mp$ 3.5, 88.8 $\mp$ 3.2, and 80.1 $\mp$ 3.4 grains, respectively. The number of filled grains also varied significantly. Seraup Kechil 146 had the highest mean of 75.8 $\mp$ 2.6 filled grains. Raminad, Seraup Besar 15, and Seraup Kechil 36 had similar statistical means of 66.1 $\mp$ 2.9, 65.6 $\mp$ 2.8, and 64.0 $\mp$ 2.9 filled grains, respectively. When adjusted to a common total number of grains on the panicle basis, the number of filled grains varied significantly, showing that factors other than the total number of grains on the panicle determined the number of filled grains. Since the total number of grains and the number of filled grains varied significantly, the number of undeveloped grains varied between varieties.

Table 1 shows that the yield of laboratory-winnowed and uniformly dried palay of the four varieties of a plot of 300 square meters varied significantly. Seraup Kechil 36 and Seraup Kechil 146 had the highest mean yield from each plot, 74.24 and 71.48 kgm., respectively; Raminad ranked second with a mean yield of 58.32 kgm., and Seraup Besar 15, last with 44.96 kgm. After converting the mean yield from each plot of each variety to the hectare basis and dividing the result by 44 kgm., it was found that Seraup Kechil 36 yielded 56.24 cavans; Seraup Kechil 146, 54.15; Raminad, 44.18; and Seraup Besar 15, 34.06.

The weights of clean rice did not vary significantly between varieties even after these weights were adjusted to a common weight of clean palay basis. Seraup Kechil 36 had an average milling percentage of 71.90; Seraup Kechil 146, 72.94; Raminad, 70.54; and Seraup Besar 15, 70.60.

SUMMARY

1. Seraup Besar 15 had the greatest mean height of plants, followed by Raminad and Seraup Kechil 146, and Seraup Kechil 36, the lowest. Raminad varied the least in height, followed by Seraup Kechil 146; Seraup Kechil 36 was the most variable.

2. There was no significant difference in the number of bearing culms to the hill of the four varieties.

3. Seraup Besar 15, Seraup Kechil 146, and Seraup Kechil 36 matured at the same time, 188 days from sowing; Raminad, in 191 days.

4. All four varieties lodged when they were nearing maturity, although Seraup Kechil 36 seemed to be resistant to strong winds.

5. Seraup Kechil 146 had the the highest total number of grains on the panicle, 98.2 $\mp$ 3.1, and in number of filled grains on the panicle, 75.8 $\mp$ 2.6. Seraup Besar 15, Raminad, and Seraup Kechil 36 had a total number of grains on the panicle of 88.8 $\mp$ 3.2, 86.5 $\mp$ 3.5, and 80.1 $\mp$ 3.4, respectively, and of filled grains of 65.6 $\mp$ 2.8, 66.1 $\mp$ 2.9, and 64.0 $\mp$ 2.9, on the panicle, respectively.

6. Seraup Kechil 36 and Seraup Kechil 146 had the highest yield of clean palay of 74.24 and 71.48 kgm. to the plot of 300 square meters, or 56.24 and 54.15 cavans to the hectare, respectively. Raminad gave a mean yield of 58.32 kgm. to the plot, or 44.18 cavans to the hectare. Seraup Besar 15 gave a mean yield of 44.96 kgm. to the plot, or 34.06 cavans to the hectare.

7. There was no statistical difference in the percentage of milling of the four varieties: Seraup Kechil 36 had 71.90 per cent; Seraup Kechil 146, 72.94; Raminad, 70.54; and Seraup Besar 15, 70.60.

TABLE 1

Actual yield of clean palay per plot of 300 square meters in kilograms of the different varieties

VARIETIES	PLOTS					TOTAL	VARIETY MEAN
	1	2	3	4	5		
Raminad	67.4	56.6	61.3	54.5	51.8	291.6	58.32
Seraup Besar 15	42.5	48.8	44.3	44.0	45.2	224.8	44.96
Seraup Kechil 146	90.1	60.4	69.5	67.2	70.2	357.4	71.48
Seraup Kechil 36	76.4	66.7	67.6	77.7	82.8	371.2	74.24

Computed yield per hectare: (dry weight basis)

Raminad = 44.18 cavans
Seraup Besar 15 = 34.06 cavans
Seraup Kechil 146 = 54.15 cavans
Seraup Kechil 36 = 56.24 cavans

Analysis of variance

SOURCES OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED *F*	TABULAR F— VALUE	
					5%	1%
Variety	3	2,716.71	905.57	16.89	3.49	5.95
Error	16	857.80	53.61			
Total	19	3,574.51				

L.S.M.D. = 9.10 kgm.

COW MANURE AS A SUPPLEMENT TO A RATION FOR GROWING CHICKS[1]

F. M. Fronda and Doroteo C. Asuncion
Of the Department of Animal Husbandry

In a report by Hammond (1942), it was shown that the feeding of dried cow manure increased the rate of growth of chicks and the development of their combs. Fred and Clark (1943) reported that cow manure checked cannibalism and contained a certain vitamin which is synthesized in the digestive tract of ruminants and which may be beneficially fed to poultry. Turner (1947) found that as a source of vitamin B complex and a male hormone, dried manure from lactating cows, when added in suitable amounts to growing rations, stimulated the development of testes and the growth rate of pullets.

From these reports, it appears that cow manure, which may be of value as a fertilizer on the farm, may also be profitably fed to poultry. To determine the influence of the addition of dried cow manure to the College standard ration for growing chicks, experiments were conducted in the Department of Animal Husbandry from May, 1946, to March, 1947.

MATERIALS AND METHODS

Stock. A total of 212 chicks composed of 50 Los Baños Cantonese, 40 Nagoya, and 122 Rhode Island Red-Cantonese crossbred chicks were used in this study. The chicks in each breed were equally divided into two lots and observed separately for a period of twelve weeks. Thus, in each lot there were 106 chicks of which 25 were Cantonese, 20 were Nagoya, and 61 were crossbred Rhode Island Red-Cantonese. The chicks were leg banded and weighed soon after they had been removed from the incubator. The weighing was done weekly thereafter until the chicks were twelve weeks old.

Each lot was raised in separate pens. The chicks had free access to a grassy yard. The feed was given in the form of dry mash in feeding troughs kept open to the birds at all times. The birds in both lots were given similar management and care.

---

[1] Experiment Station Contribution No. 1514. The data presented in this paper were taken from the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1948.

Read before the one-hundred-and-seventy-eighth scientific meeting of the Los Baños Biological Club, August 27, 1948.

Ration. Lot I was given the College standard ration for growing chicks. This ration consisted of the following ingredients, all parts by weight: fine rice bran, 55; ground corn, 20; shrimp meal, 20; and copra meal, 5. The feed given to the birds of lot II consisted of the same basal ration supplemented with dried cow manure to the proportion of 10 parts of the standard ration to one part of manure.

The cow manure was collected from the barn of the Department of Animal Husbandry early in the morning and dried in the sun to a more or less constant weight. This manure, however, included some of the urine of the animals. Before the dried manure was mixed with the basal ration, it was ground fine. It was observed that it took from 7 to 8 days to dry a five-gallon can of fresh manure weighing 15.6 kilograms to a constant air-dry weight of 11.4 kilograms.

RESULTS AND DISCUSSION

Rate of growth of the chicks. The weekly increase in weight of the chicks was used as the criterion to determine the effect of the dried cow manure as a supplementary feed on their rate of growth. Although the average initial weights of the chicks in both lots of the same breed were practically the same, on the whole, an appreciable amount of variation in the rate of growth of the chicks was observed during the experimental period of twelve weeks.

The average weekly increase in weight of the birds in one lot was compared statistically with the increases of corresponding lots, each breed being taken separately. The differences in the weekly increase in weight of the chicks in the control and experimental lots for the breeds were found to be significant. The Cantonese weanlings in lot I weighed 360.0 $\mp$ 1.60 grams and those in lot II, 635.0 $\mp$ 1.90 grams; the Nagoya weanlings in lot I weighed 436.8 $\mp$ 3.20 grams and those in lot II, 624.5 $\mp$ 6.60 grams; and the Rhode Island Red-Cantonese crossbred weanlings in lot I weighed 344.1 $\mp$ 8.90 grams and those in lot II, 599.2 $\mp$ 5.80 grams.

The results obtained from this study corroborated the findings of previous workers. According to Rubin, Bird, and Rothchild (1946), Witson, Hammond, Titus, and Bird (1945) showed that 8 per cent of dried cow manure and 3 per cent of sardine fish meal were about equally effective in improving the growth response of chicks fed with an all-plant-protein basal diet containing 35 per cent of soybean meal. They concluded that the growth-promoting effect of cow manure was due to a protein or to any of the vitamins. Rubin, Bird, and Rothchild (1946) also report Rubin and Bird's (1946) presenting evidence to show that the growth factor in cow manure was not identical with any of the chick growth factors previously found by other workers. Turner (1947) found that 10 per cent cow manure influenced the development of testes, stimulated the

growth rate of pullets, and slightly hastened the onset of egg production. Norris [2] believed that the growth factor found in the feces of cattle and chickens was synthesized by bacterial action either in the lower portion of the intestinal tract or after the feces had been voided.

Amount of feed consumed. The amount of feed consumed by the three breeds was observed to be variable. The Nagoya consumed the most feed; the crossbred Rhode Island Red-Cantonese, the next; and the Cantonese, the least.

It was noted, however, that the amount of feed consumed by each lot of one breed was practically the same. On the basis of 100 chicks, the Cantonese chicks in lot I consumed only 1.38 kilograms of feed more than that consumed by those in lot II; the Nagoya chicks in lot II consumed 9.64 kilograms of feed more than that consumed by those in lot I; and the crossbred Rhode Island Red-Cantonese chicks in lot II consumed 15.89 kilograms more than the feed consumed by the chicks in lot I. The amount of cow manure supplement necessary to raise 100 chicks to the weaning age of twelve weeks was 28.8 kilograms for the Los Baños Cantonese; 31.86 kilograms for the Nagoya; and 32.09 kilograms for the crossbred Rhode Island Red-Cantonese.

The amount of basal feed required by the Cantonese in lot I to produce one kilogram weanling weight was 8.83 kilograms. Those in lot II required only 4.95 kilograms, or 3.88 kilograms less than that needed in lot I. The Nagoya in lot I needed 7.73 kilograms and those in lot II, only 5.64 kilograms, or 2.09 kilograms less than that in lot I. The Rhode Island Red-Cantonese crossbred in lot I needed 9.90 kilograms and those in lot II, only 5.88 kilograms, or 4.02 kilograms less. From these figures, without considering the labor spent in collecting, drying, and grinding the cow manure, it may be concluded that the addition of dried manure to the ration produced weanlings more economically than the standard ration alone.

Mortality and vigor of the chicks. Mortality figures showed that the birds in lots II in all the breeds had a lower mortality than those in lots I. The mortality among the Los Baños Cantonese chicks was 60 per cent in lot I and only 36 per cent in lot II. With the Nagoya chicks, the mortality in lot I was 40 per cent and in lot II, 25 per cent. The 50.8 per cent mortality among the crossbred Rhode Island Red-Cantonese chicks in lot I was partly due to roup which occurred during the last eight weeks of the experimental period. The chicks in lot II of the same breed were also affected, but only to a slight degree, the mortality in this lot being only 39.3 per cent.

---

[2] Norris, L. C. 1947. Vitamin science. Hatchery Tribune. February, 1947: 30.

Other minor observations. The chicks given the ration supplemented with dried cow manure (lot II) appeared healthier and more uniform in size than those in the control (lot I). The chicks of the manure-fed lot in all the breeds studied feathered earlier and were more active and better grazers than those that did not receive cow manure in the ration. Since the combs and wattles of the weanlings in the manure-fed lot were more fully developed at twelve weeks of age than those in the control, they appeared to have matured earlier. The chicks of the manure-fed lot relished their feed as well as those in the control.

SUMMARY

1. The dried-cow-manure-fed chicks grew faster and were uniformly heavier than those that did not receive cow manure in the ration.

2. The ration supplemented with dried cow manure appeared to be as well relished by the birds as the unsupplemented one.

3. The addition of dried cow manure to the ration produced weanlings more economically than the standard ration alone.

4. The addition of cow manure to the ration lowered the mortality of the chicks.

LITERATURE CITED

FRED, E. B., and H. E. CLARK. 1943. Annual report Wisconsin Agric. Exper. Sta. Bull. 463 (Part II): 33-35.

HAMMOND, J. C. 1942. Cow manure as a source of certain vitamins for growing chickens. Poultry Science 21: 554-559.

RUBIN, M., and H. R. BIRD. 1946. A chick growth factor in cow manure. 1. Its non-identity with chick growth factors previously described. Jour. Biol. Chem. 163: 387-392.

RUBIN, M., H. R. BIRD, and I. ROTHCHILD. 1946. A growth promoting factor for chicks in the feces of hens. Poultry Science 25: 526-528.

TURNER, C. W. 1947. Dried lactating cow manure in the ration of growing chickens. Poultry Science 26: 143-149.

WITSON, D., J. C. HAMMOND, H. W. TITUS, and H. R. BIRD. 1945. The use of soybean meal in the diet of growing chicks. II. The effect of different grains. Poultry Science 24: 408-416.

CAN MALE DUCKS BE CAPONIZED FOR PROFIT?[1]

LEODEGARIO J. DEL ROSARIO

Caponizing surplus cockerels is a usual practice among raisers of chickens, since capons exhibit so remarkable a growth that keeping them up to eight months after caponizing is profitable. Capons excel roosters of the same age in meat quality and dressing percentage, and they command a better market price than the latter. Because of their quiet and docile nature, capons can be more satisfactorily grown in larger flocks than cockerels.

No work along this line has yet been done in the case of male ducks. This study was conducted for the purpose of determining the influence of caponizing male ducks on the rate of growth and on the quality of their meat. This work was conducted in the Department of Animal Husbandry from April 1, 1947, to December 31, 1947.

MATERIALS AND METHODS

One hundred fifty ten-week-old male ducks were used in this study. After they had been wing-banded, they were divided according to their weights into two groups of 75 birds each. One group designated as lot 1 was caponized on May 10, 1947, and placed in one pen; the other group designated as lot 2 was left uncaponized and placed in an adjoining pen. Both lots were observed for thirty weeks following the operation.

The same method used for caponizing chickens was employed in caponizing the ducks. As this was the first trial in caponizing male ducks, several individuals were caponized before operating on the ones used in this experiment.

The ration given to the ducks in both lots consisted of 60 parts of fine rice bran, 20 parts of ground corn, 10 parts of copra meal, and 10 parts of shrimp meal — all parts by weight. An unlimited amount of chopped green feed was given daily to the birds.

The feed was given as sloppy mash in wooden troughs four times a day — at 6:00 and at 10:00 o'clock in the morning, and at 2:00 and at 6:00 o'clock in the afternoon. Clean drinking water in bamboo troughs was made available to the ducks at all hours during the day. They were supplied with chopped green feed during the second feeding time in the morning. .

---

[1] Experiment Station Contribution No. 1515. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1948. Prepared in the Department of Animal Husbandry under the direction of Professor F. M. Fronda.

Biweekly weights were taken after the initial weighing at caponizing period in order to determine the rate of growth. The ducks were weighed before giving them their feed at two o'clock in the afternoon.

Ten birds were taken from each lot at random at the end of the experiment for the purpose of determining the dressing percentage and the cooking quality of the meat. The birds were not given feed for twenty-four hours before dressing, but they were given plenty of water. They were weighed before and after dressing to determine the dressing percentage. To determine the cooking quality of the meat, the dressed capons and drakes were paired and distributed to different individuals. Six of these pairs were given to six housewives who were requested to cook them separately but in the same manner. The remaining four pairs were roasted, and the Animal Husbandry 199 class was requested to test the meat. The opinions of these different individuals were used as the basis of the statement regarding the quality of meat.

RESULTS AND DISCUSSION

Rate of growth. It was observed that the highest average weight of both the caponized birds and the drakes, recorded twelve weeks after caponizing time, was 1,282.2 $\mp$ 13.2 grams for the capons and 1,263.9 $\mp$ 15.1 grams for the drakes. The difference of 18.3 $\mp$ 20.0 grams in favor of the capons is not statistically significant. After this period, the weights of the birds in both lots remained more or less constant. If the heaviest weight of the birds were to be used as the criterion for the right time to dispose of the birds, these results would show that male ducks (drakes and/or capons) raised for meat should be marketed not later than the age of 22 weeks.

The biggest average gain in weight for both capons and drakes was recorded during the second week of the experiment (the birds were then 12 weeks old) when lot 1 made an average gain of 114.4 grams and lot 2, 150.2 grams. The difference of 35.8 grams is insignificant. The apparently higher average gain in weight made by the drakes may be due to the fact that the caponized birds at this age had not fully recovered from the effects of the caponizing operation. The drakes had a decrease in weight of 31.7 grams on the sixth week, probably on account of the sudden occurrence of hard rains during this period. It was observed that during heavy rains the ducks did not consume all the feed given them; instead, they ran back and forth from the house to the yard. For a possibly similar reason, decreases in weight in both lots were observed from the fourteenth to the eighteenth weeks, during which period the capons had an average total decrease of 68.5 grams and the drakes, 39.3 grams. Again, decreases in average weights of the ducks were recorded during the twenty-fourth, twenty-sixth, and

the twenty-eighth weeks after caponizing. The storms on October 30, November 6, and November 16, 1947, might have caused such loss of weights. From the experience gained in the study, it would seem advisable during rainy days to confine ducks inside the house in order to prevent them from moving around too much and thereby neglecting their feed.

It was also observed that the total weight of the 71 capons (lot 1) at the close of he experiment was 89,206 grams and that of the 70 drakes (lot 2), 77,370 grams. The average weight of each bird in lot I was 1,258.6 and in lot 2, 1,105.9 grams, the capons weighing 152.7 grams more than the drakes. It can be seen, therefore, that at the close of the experiment lot I had an average gain of 337.4 grams over their initial weights at the start of the experiment while lot 2, only 179.4 grams. There is a significant difference of 158.0 grams in favor of the capons. At the close of the study, the capons gained 36.6 per cent over their original weight while the drakes, 19.3 per cent only.

Feed consumption. The capon lot was observed to have consumed a total of 1,305 kilograms of feed during the entire experiment of 30 weeks, or an average of 18.4 kilograms for each bird. The drake lot during the same period consumed 1,285 kilograms of mash, or an average of 18.4 kilograms a bird. These figures show that amount of feed consumed by both the caponized birds and the drakes was practically the same. Considering that the caponized birds had heavier bodies which should require more feed for maintenance, it appears that they made better use of their feed than the drakes. Actually, the capons required 14.6 kilograms of feed for every kilogram of body weight, and the drakes required 16.6 kilograms.

Mortality. Four capons and five drakes died during the experiment. Two of the capons died during the first week of the study, possibly owing to the weakness brought about by the operation, and two died probably of suffocation. Two deaths among the drakes occurred on August 30, 1947, when the house was flooded on account of a heavy rain. Three others died on June 2, August 17, and October 24, 1947, possibly of suffocation. The total percentage of mortality in both lots was practically the same — 5.63 per cent in the capon lot and 7.14 per cent in the drake lot.

Dressing percentage and quality of the meat. It was observed that the average live weight of the 10 capons studied was 1,296.9 $\mp$ 23.3 grams and the average dressed weight, 1,060.8 $\mp$ 17.2 grams, the average dressing percentage being 81.8 $\mp$ 0.6. The drakes had an average live weight of 1,155 $\mp$ 40.0 grams, an average dressed weight of 897.7 $\mp$ 33.7 grams, and an average dressing percentage of only 77.8 $\mp$ 1.7. The difference of 4.0 per cent in favor of the capons is significant.

The reports of those who tested the quality of the meat of the capons and drakes were almost unanimous in stating that there was a very little difference in the quality of the meat of these birds. The meat of the capons was perhaps only a shade finer in texture and probably a little more juicy than that of the drakes. For this reason, it is doubtful if caponizing for the purpose of improving the meat could be recommended. A few reports mentioned, however, that the "duck" flavor was not so strong in the capon's meat as it was in the meat of the drakes.

Other observations. It was observed that male ducks were not not so easy to caponize as the chickens. One reason for this is that the testes of the ducks are longer and more slender than those of the chickens. Also, in the ducks, these organs were observed to be more closely attached to the dorsal wall of the abdominal cavity than in chickens. The difficulty in caponizing ducks could perhaps be overcome by having a longer spoon remover to hold the enter length of the testes, thereby minimizing the possibility of breaking this organ while it is being detached.

The capons, after recovering from the effects of caponizing, were observed to be as active as the drakes. However, their feathers were less shiny than those of the drakes. In the capons, the curly feathers on the tail — a characteristic of the drakes that distinguishes them from the females — remained. Caponizing did not alter the active disposition and nervous temperament of the birds.

SUMMARY

1. The caponized male ducks had an average gain in weight of 337.4 grams and the drakes, 179.4 grams at the close of the experiment. The difference of 158.0 grams in favor of the capons is significant. With this little difference, it is doubtful if caponizing male ducks could be recommended.

2. The caponized ducks apparently made better use of the feed than the drakes. For every kilogram of live weight, the caponized birds needed only 14.6 kilograms of feed and the drakes, 16.6 kilograms.

3. The percentage of mortality in both the caponized and the drake lots was practically the same.

4. The average dressing percentage of the caponized ducks, 81.8 ∓ 0.6, was significantly higher than that of the drakes, 77.8 ∓ 1.7.

5. Very little advantage, if any, was gained in the quality of the meat of caponized male ducks.

COLLEGE AND ALUMNI NOTES

The 30th annual celebration of Loyalty Day was held on October 10, 1948, with Honorable Thomas H. Lockett, Charge d'Affaires, American Embassy, as the guest of honor. The general program consisted of a parade on the campus and a program at Baker Memorial Hall in the morning; luncheon for guests and alumni at noon; basketball games in the afternoon; and a dance, sponsored by the student body organization, in the evening.

In his speech, Mr. Lockett touched on the background of the Loyalty Day celebration, stressed the close Philippine-American relations during the last two years, and presented a picture of a threatening world conflict today. He was introduced by President B. M. Gonzalez. Dean L. B. Uichanco administered the Oath of Loyalty. Dr. J. M. Capinpin gave the opening remarks and Rev. Roman E. Baes, the invocation. The musical numbers were rendered by the Camp Murphy Band conducted by Major Laureano G. Cariño, and by Misses Pilar Benavidez, Lucy Nico, Corazon Libunao, and Andrea Ofilada, all of the U. P. Conservatory of Music.

More than one hundred alumni from the different parts of the Philippines, excluding those connected with the College, participated in the celebration of 1948 Loyalty Day on October 10. Among those present were the following: Class of 1913 — B. M. Gonzalez; 1914 — Francisco Galang, Antonio Lejano; 1915 — Agripino Constantino, Nicanor G. Teodoro; 1916 — Marceliano Constantino; 1918 — Ramon V. Manio, Faustino Q. Otanes, Eduardo Quisumbing, Claro Samonte; 1919 — José P. Esguerra, Joaquin J. Gonzalez, Teofilo Nisce, E. F. Roldan, Deogracias Villadolid; 1920 — Nemesio Catalan, Rufino Isidro; 1921 — Victor C. Aldaba, Dionisio Aquino, Artemio Manza, Onofre Ricafrente, Eligio C. Ureta; 1922 — Basilio D. Desembrana; 1923 — Ramon A. Cruz; 1924 — Basilio L. Hernandez; 1925 — Fidel M. Reyes, Cornelio V. Crucillo; 1927 —Fernando Ordoveza; 1928 — Dominador Z. Rosell, Felix F. Villa; 1929 — Martin S. Celino; 1930 — Jesus P. Mamisao; 1931 — Santiago R. Capco, Juan O. Sumagui; 1932 — Florencio Y. Gopez, Porfirio R. Manacop, Andres N. Mane, Juan Villaroel; 1933 — Pacifico L. Bautista, Alfredo A. Francisco, Leonor Pandinco-Garcia, Crispiniano C. Hernandez, Bartolome P. Javier, Ponciano F. Ortiz, Guillermo O. Palis, José N. Quintos; 1934 — Victorino Borja, Osmundo Mondoñedo, Nicomedes C. Reyes, Generoso F. Tanseco, Alfonso L. Tecson; 1935 — Proceso E. Alcala, Alberto C. Felix, Fabiano O. Solpicio; 1936 — José E. Borromeo, Simeon M. Inumerable, Leandro R. Lopez, Cornelio Macabasco; 1937 — Domingo M. Altamirano, Nicanor M. Alvaro, Crispin Dacanay, Leona Atienza-Dacanay, Amando M. Dalisay, Conrado C. Dinulos, Ruperto Evangelista, Doroteo F. Tinio; 1938 — Glicerio M. de las Alas, Juan Fandialan, Socorro Olalde-

Mangabat, Democrito Topacio; 1939 — Severino Hermosura, Ramon Samaniego, Ascario G. Tuason; 1940 — Horacio M. Gomez, Agustin Mañgila, Pericles S. Subido; 1941 — Hipolito A. Custodia, Felix G. Requeño, Paterno R. Santos; 1942 — Miguel B. Cosico, Antonio G. Maclan; 1943 — Gabino P. Mangabat, Benjamin Samala; 1944 — Eleazar M. Galano, Justo Gonzalez Jr., Nelia Teodoro-Gonzalez; 1945 —José M. de la Cruz, José T. Tapay, Jorge Villegas; 1946 — Telesforo Angeles, Abelardo Baclig, Dolores Barile, Melchor E. Fronda, Rufo H. Ocfemia, Celso G. Santos, Pacifico B. Torio, Felix B. Villamayor; 1947 — Juan C. Bunoan, Jr., Lydia Catalan, Leonardo Catral, Feliciano I. Garcia, Enrique Lantican, Miguel D. Paguio, Lamberto Tolentino; 1948 — Renato I. Capinpin, Mario Belisario, Florentina Ortiz, Alfredo M. Lioanag, Eugenio V. Mendoza, Maximino Reaño, Teodomero Yñiguez. Many alumni do not appear in the list owing to their failure to sign the guest book.

Telegrams of greetings and felicitations were received on Loyalty Day from Felipe Aala, '34, and José Alhama, '33, of Bacolod City; and from Constancio T. Medrana, '27, Severino Aquino, '22, Luis H. Dangilan, '24, Abelardo Gatan, '38, Felix Remigio, '38, Serapio Bayubay, '43, and Santos Llana, '44 of the Trinidad Agricultural High School, Mt. Province.

Undersecretary José S. Camus, '14, has recently returned from the United States where he stayed for three months to assist Ambassador Elizalde and Secretary Cuaderno in securing a big loan for the industrialization program of the Philippines.

Dr. F. O. Santos, '19, head of the Department of Agricultural Chemistry, and Dr. Amando M. Dalisay, '37, of the National Economic Council, were among the speakers at the public conference on rice, which was held under the auspices of the Philippine Association of Nutrition in Manila on October 2, 1948.

Dr. Anastacio L. Teodoro, '18, of the Machinery Division of the NDC, and Mr. Gil. O. Opiana, '23, chemist of the Institute of Science, have been sent to Japan as technical representatives to make a survey of reparation materials for the Philippines.

Miss Filomena G. Mercado, '48, a graduate from the College of Education, U. P., major in library science, has been appointed librarian of the College, effective July 26, 1948.

Dr. Valente Villegas, head of the Department of Animal Husbandry, was recently nominated "socio corrispondente" by the Societa Italiana Per Il Progresso Della Zootecnica Milano.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS AS OF MARCH, 1949

No. 2.—Bud Rot of Coconut ..... *By G. O. Ocfemia*

No. 8.—Horse Breeding in the Philippines ..... *By V. Villegas*

No. 10.—Practical Directions for Coffee Planting *By Pedro A. David* (Revised by Charles Fuller Baker, Dean, College of Agriculture, 1917-1927.)

No. 11.—The New College Copra Drier—Prepared in the Department of Agricultural Chemistry with the Cooperation of the Department of Agronomy and Extension (Revised) ..... *By Moises M. Kalaw*

No. 17.—College Trapnest ..... *By F. M. Fronda and P. S. Paje*

No. 18.—Surveying for Area with a Surveyor's Staff ..... *By Alexander Gordon*

No. 23.—Curing Pork and Making Sausage for Home Use ..... *By Mariano Mondoñedo*

No. 24.—Construction and Operation of Silos in the College of Agriculture ..... *By J. P. Esguerra*

No. 26.—Training Cattle and Carabaos for Work ..... *By Valente Villegas*

No. 28.—Cotton Culture ..... *By Eulalio P. Baltazar*

No. 29.—Collegiate Education in Agriculture *By Leopoldo B. Uichanco*

No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? ..... *By N. B. Mendiola*

No. 32.—Hog Raising (Revised, mimeographed) ..... *By Mariano Mondoñedo*

The price of the circulars listed above is thirty centavos (P0.30) each.

ALL ORDERS WITH PAYMENT SHOULD BE ADDRESSED TO THE BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, COLLEGE, LAGUNA, PHILIPPINES.

The Philippine Agriculturist

(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE

UNIVERSITY OF THE PHILIPPINES

Vol. I—2

Vol. III—9-10

Vol. IV—3, 5-6, 7

Vol. V—2, 3, 5, 6 7, 8, 9, 10

Vol. VI—complete

Vol. VII—complete

Vol. VIII—3, 4, 5, 6, 7, 8-9, 10

Vol. IX—3, 4-5, 8-9

Vol. XI—3, 4, 5, 6, 7, 8

Vol. XIII—1, 3, 4, 5, 6, 8, 10

Vol. XIV—complete

Vol. XV—complete

Vol. XVI—complete

Vol. XVII—6, 7, 8, 9, 10

Vol. XVIII—complete

Vol. XIX—complete

Vol. XX—complete

Vol. XXI—complete

Vol. XXII—complete

Vol. XXIII—complete

Vol. XXIV—complete

Vol. XXV—complete

Vol. XXVI—complete

Vol. XXVII—complete

Vols. XXVIII, XXIX and XXX—burned.

Separate indices to Vol. 1 to XXVI

Consolidated index to Vol. I to XX

Back copies sell at 50 centavos.

Consolidated index 50 centavos excluding postage.

Send your order to the BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, COLLEGE, LAGUNA, PHILIPPINES.